Joint Government/Industry/University Computer Supported Cooperative Work (CSCW) Initiatives in Great Britain

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1. INTRODUCTION

Joint forces Command, Control, Communication, and Intelligence (C3I) will require collaborative technologies to support complex, distributed problem solving and crisis management. The main purpose of this document is to report on Great Britain's efforts to leverage government/industry/university expertise and resources to accelerate research and development in collaborative technologies, especially how it applies to C3I. Additionally, because some limited residual funds were used to travel to related workshops at AAAI 94 and CSCW 94, summary information related to C3I gathered at these places will also be presented in the appendices.

2. DEPARTMENT OF TRADE AND INDUSTRY/SCIENTIFIC AND EDUCATION RESEARCH COUNCIL JOINT PROGRAM IN COMPUTER SUPPORTED CO-OPERATIVE WORK (DTI/SERC CSCW)

Great Britain has recently funded eight projects as part of its Joint Framework for Information Technology (JFIT) Computer Supported Cooperative Work (CSCW) Program. Dissatisfaction with the lack of technology transfer from previous government supported research in CSCW motivated the current structure, i.e., the British government was concerned that previous investments in CSCW have not paid-off. The next two sections provide a brief history of previous funding efforts and describe the selection process for the projects that were chosen.

2.1. Previous British Governmental Funding in Information Technology

In response to Japanese Government Initiatives in Information Technology, in 1984, the British Government funded a five year research program in information technology known as ALVY. The British Government also funds the ESPRIT Research Programs which supports basic research programs across Europe.

Searching for greater tangible results from its investments, government policy makers became convinced that industry should take the lead in transitioning basic research into applied research areas which would provide greater payoff for Britain's industries.

2.2. The Selection Process

The response to this search for greater tangible results was an open process involving government, industry, and university representatives. CSCW was viewed as one area that offered the greatest potential to impact British industry. However, the lack of emphasis on "how people actually work" in past CSCW research was seen as the reason there were limited benefits from previous funding efforts.

Prior to the call for proposals, a series of meetings occurred among government, industry, and university personnel who were most knowledgeable in CSCW. Participants

reviewed assumptions based on previous CSCW efforts and developed a work plan based on key issues. Proposals were to address one or more of three areas [Shephard, 1994]:

- Learning by applying - an interactive approach to ensure that the methods, products and services being developed are suitable for real-world use.
- Enabling technology - new infrastructure, tool sets and capabilities to broaden the applications for CSCW.
- Supporting people - investigating how people work together and what tools are of most benefit.

Thirty-six proposals were submitted, from which eight were chosen. The successful consortia included academic centers, vendors, users and entrepreneurs; were multi-disciplinary, and focused on understanding how people actually work and may effectively employ CSCW tools. Government funding is approximately $8.8 million over three years. Commercial members of the consortia are expected to contribute at least as much, for a total of over $17.5 million.

3. THE PROJECTS

Shephard (1994) provides a good summary of the projects and was used as the major source for the following. More information on the projects, much of it obtained from the Conference, "Tomorrow's Organization", can be found in the Appendices.

3.1. The Business Flight Simulator

The Business Flight Simulator combines existing groupware tools such as group decision support, desk-top conferencing, and asynchronous shared document sharing to support "trouble shooting" and "what-if" scenario testing. The flight simulator will be mobile and configurable to support a range of organizational problem solving needs.

3.2. VIRTUOSI - Support for Virtual Organizations

VIRTUOSI combines virtual reality with long distance communication technologies. The goal is to create a visualization which can be shared by people in many different locations. One application will be the virtual catwalk. It will allow garment designers to discuss their designs with production and marketing professionals as they all view a "virtual" fashion show. Another application will be to create a virtual factory which can be viewed from anywhere in the world.

3.3. SYCOMT - System Development and CSCW: Methods and Techniques

SYCOMPT will explore work practices and productive methods in order to devise ways to develop products which relate more effectively to the way work is performed. Advanced techniques for analyzing people in work environments and the management of change will be exploited to define guidelines for other organizations undergoing structural changes.

3.4. CD - Collaborative Documents

CD will apply work flow to document management and develop the concept of the reflexive document which "speaks for itself." Work flow, image processing, and wide area networking technologies will be combined to bring the documents and the activities of a distributed group into the same environment, enabling them to perceive and develop essential relationships between information and work processes.

3.5. CORECT - Collaborative Requirements Capture

CORECT will create a system to support the definition and translation of engineering product requirements. Usually, customers, marketing specialists, and engineers, because of their different backgrounds and capabilities, find collaboration difficult. To support interaction, an advanced collaborative authoring environment will be coupled with the ability to use natural language expression.

3.6. DUCK - Designers' Use of Co-operative Knowledge

DUCK will support collaboration of a distributed team of designers by recording the collaborative rationale of the design process. Pen-based computing techniques will permit designers to sketch on-line. DUCK will provide a process history to enable future project participants, such as production or marketing personnel, to understand the design rationale.

3.7. ICW - Integrated Co-operative Workspace

ICW aims to develop an open infrastructure to facilitate enterprise-wide and inter-organizational collaboration. The results of this project will include a reusable tool set that is based on industry standards and capable of running across a wide range of hardware.

3.8. STARTED - Strategies, Tools, and Resources for Team-based Early Design

STARTED will employ fuzzy logic to reduce the risks associated with collaborative project definition and cost estimates. The project will produce tools for information viewing, hyper-text browsing, total cost calculation, and risk estimation.

4. SUMMARY AND CONCLUSIONS

The major lesson of these British efforts in CSCW is the focus on getting payoff from governmental expenditures in technology and the conclusion that successful technology transfer, especially in CSCW, will only occur by understanding how people really work. This focus is better understood when you comprehend the history of previous British governmental funding and understand the special requirements of CSCW research. All these projects have the potential to inform aspects of the design,

development, and implementation of collaborative technology to support C3I. Their progress and lessons learned from these efforts are worthy of continued monitoring. Doug Engelbardt, the CSCW visionary provides an apt warning which Great Britain has tried to address. Only time will tell if it is effectively addressing these concerns.

> *A disastrous default mode would be for the perceptions of the technologist and the market-oriented product planners to steer the evolution of the Tool System, and leave the Human System to adapt in its trail* [Engelbardt, 1982].

5. ACKNOWLEDGMENTS

I thank my chairman, Dr. Frank Friedman, of Temple University and Dr. Andre M. Van Tilborg of the Office of Naval Research for partially supporting this work. I thank all the people who assisted me in understanding these joint research efforts in Great Britain, and I especially want to thank three people who gave freely of their time and provided invaluable insights to these projects: Mr. Garth Shephard of Envisage Ltd, Dr. Tom Rodham of Lancaster University, and Dr. Fran Ackerman of the University of Strathclyde.

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APPENDICES

Appendix A
The Business Flight Simulator

Several aspects of this project are especially relevant to C3I.

- The metaphor of the flight simulator. There is more evidence, that in difficult problem solving in uncertain environments, the most important support can be war-gaming/scenario testing in advance. The military has always led the way in this. What this project will do is provide information technology to support the group decision process.

- Mobile tool set. Setting up mobile group decision support environments is especially appropriate and there are at least two prototype efforts I know about in the Army and the Air Force.

- Better visual interface. The researchers are experimenting with a better visual interface which will permit participants to better navigate through the processes involved in group problem solving. The poor interface features of current group decision support systems are a major limitation to their acceptance and widespread use.

- Cognitive Mapping Tools. Graphics Cope is one of the tools which is being incorporated into this project. It is less structured that other similar mapping tools and uses clustering techniques to discern useful relationships. While the researchers are convinced of the value of graphical representations, there is little experimental proof of these field cases. Graphics Cope is actually just one tool in a process of strategic planning and is usually introduced after the participants have used manual tools to indicated importance.

  One interesting sidebar to this research is the use of dots for weighting. A group of participants can be given some number of dots, physical now, electronically in the future, and they distribute them to the list of statements uncovered during a group discussion period of the problem. For example, if there are a hundred dots available, instead of writing the number 20, 20 "dots" would be placed along side a particular statement. It is assumed that the "volume" of the dots provides a greater visual cue as importance than the number 20.

  The Air Force has done some work in cognitive mapping for knowledge acquisition of system requirements, but is not as active in this research now.

  The use of cognitive mapping is just in its infancy and should continue. The technology is now beginning to overcome some the information management complexity involved in cognitive mapping.

TOMORROW'S ORGANISATION

2. THE BUSINESS FLIGHT SIMULATOR

THE B.F.S. CONSORTIUM

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The business flight simulator

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Historical perspective

The aim of this paper is to outline the principles behind the BFS, its architecture and operation. But first some background is needed.

From time immemorial, and certainly for the last 5000 years, managers at all levels have used groups and teams for advisory purposes, for communications purposes, and for decision-making. What is particularly striking about so many of the management meetings of today is that they take place with rudimentary technology - flip charts, white boards and simple overhead projectors. Even the use of computer-based presentations scarcely moves further than the Victorian epidiascope technology. The use of computer technology to support groupwork has scarcely penetrated the great majority of management meetings.

The first major work in this area was carried out by Doug Englebart at the Stanford Research Institute (SRI) in the mid 1960's (Englebart, 1962). His project, concerned with the "Augmentation of Human Intellect", involved supporting meetings of a dozen or so white-collar workers with a mini-computer based collaboration system Augment.

When Xerox set up its Palo Alto Research Centre (PARC) in 1970, it recruited many key staff from SRI. It was therefore hardly surprising that when Xerox developed the world's first personal computer (the Xerox Alto) in 1973, it very quickly became networked, using the early versions of Ethernet. This was Version 1 of Personal Computing: essentially collaborative.

Version 2 of Personal Computing derived from the "home-brew" computing movement of the mid to late 1970's, typified by the Apple 1 and Apple 2 computers. Unfortunately, when IBM launched its PC in August 1981, it

chose to go down the Version 2 route. This was an individualistic route, where there was little or no conception of, or interest in, networking the PC.

Since it was the IBM PC that dominated the business desktop in the 1980's, and not the Xerox PC, this commercial dominance of Version 2 has set back the whole area of computer supported group working in business by many years. Not only are there even today still significant technical inconveniences in networking disparate PC-based products, a decade of primarily personal use of PC's has also created work habits that are not geared to group use of IBM-compatible PC's.

So in addressing the question of intensive computer support to managerial groups, there are two preliminary obstacles - one technical, one related to lack of a group perspective in use of computers generally.

Groupware

There are now a very wide variety of commercially available groupware products. In Holtham (1993), a matrix was developed to classify these products (Figure 1), based on the business processes - those core activities which cut across departments and job functions - to which groupware can be applied. The axes relate to the level of management process, and the degree of interactivity within the group.

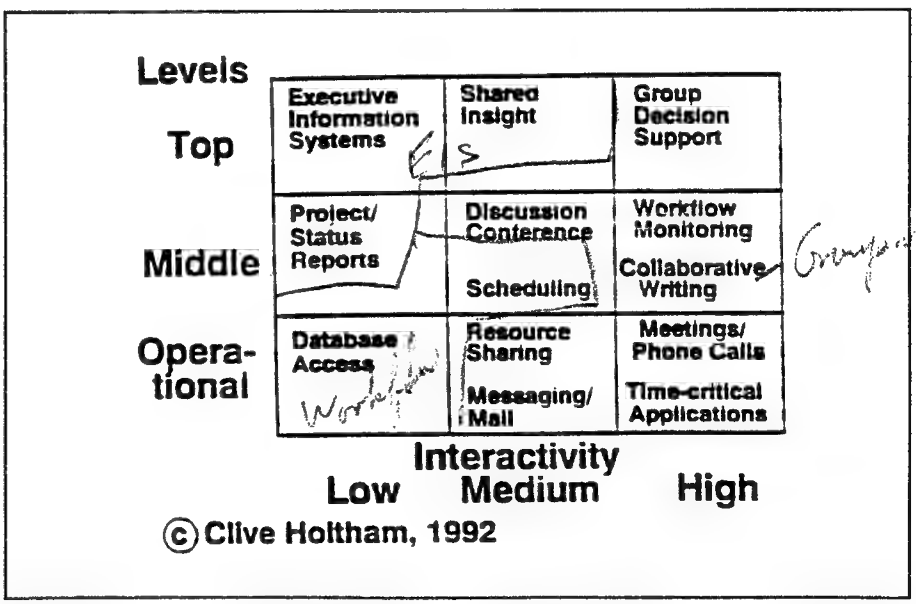

Figure 1: Information processes by pyramid management levels and interactivity

Most individual groupware products cover only small parts of this grid. But managerial needs span the whole grid, and since this is the domain of the BFS, the project needs to work with and integrate a very wide variety of groupware tools.

Collaborators

There are five major industrial collaborators in this project:

* ACT Business Systems - project management and consultancy
* Bull Information Systems UK - provision of hardware, networking and systems integration
* Esmerk Ltd - provision of real-time and historic data feeds
* PCL Ltd - technical integration of groupware and information tools
* Touche Ross - process methodology and integration

City University Business School is the lead academic collaborator. An academic steering committee has been created involving three other business schools - Strathclyde, Loughborough and Cranfield. There are also a number of other industrial collaborators, which comprise a "Collaborative Club."

Operation of the Simulator

The structure of the Business Flight Simulator is summarised in Figure 2.

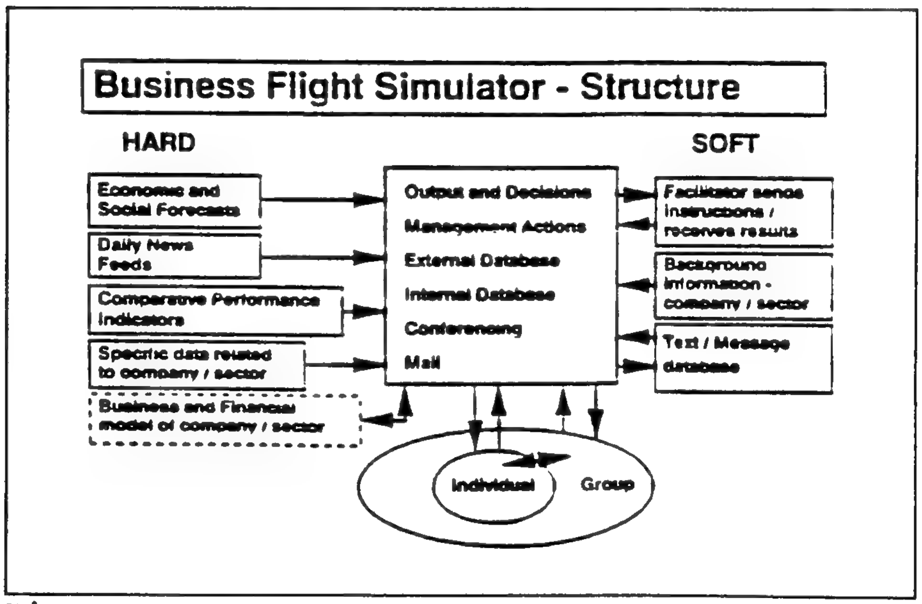

Figure 2

The central core is a local or wide area network, with immediate availability of a variety of existing groupware packages. This network physically supports a group involved in an important piece of collaborative work. This work typically involves access to "hard" data: forecasts, databases, news and information feeds, and financial data. There will be "soft" data also - in informal discussions and controversies.

Group members partly work on an individual basis, synthesising data and brainstorming, and then actively collaborating with colleagues via computer conferencing and electronic mail. Those working in the same place can also use ordinary meetings as appropriate. The aim is certainly **not** to replace all

face to face contact by a wholly electronic support environment. A facilitator can introduce additional ideas and challenges at any time. The group will typically need to conclude by producing a policy document or action plan.

Settings

Applications of the BFS involve at least three different settings:

1. Running the simulation on an organisation's own premises over a finite period of time e.g. ½ - 1 day. This is typically a real planning or strategy meeting.

2. Running the simulation as in 1, but with some participants physically remote, interacting for the finite period by electronic methods. In further stages of development there are plans to supplement this with video conferencing links.

3. Running the simulation over an extended period of time, using databases and communications facilities held at one or more central locations, with participants using PC's either at home or at their normal desktop.

The initial BFS has work has been carried out using the "LAN in a Suitcase". This is a portable local area network, using notebook computers, a server with Novell Netware and a variety of groupware packages. The notebooks are connected via parallel port ethernet adapters.

Platforms and core products

Because at the PC level Windows 3 is likely to be the dominant GUI over the period of the study, then it was most appropriate to select tools which are available under Windows 3. But it would be ideal to use tools that could perform across Windows 3, Apple and Unix/X-Windows.

There are several core products, which will be used in many of the BFS test sites. One is Lotus Notes, which provides electronic Mail, computer mediated conferencing (Discussion Databases), an applications development environment and sophisticated access for laptop users.

A second is VisionQuest. This is a real-time electronic brainstorming and voting package. The third core package is Fujitsu Desktop Conferencing (DTC). This enables users on a local area network to share screens, and to create shared "electronic flip charts" superimposed on those screens, which can then be stored within Lotus Notes databases.

Architecture

As the project has developed, the experience of integrating widely disparate systems (all nominally PC, Novell and Windows based) has proved to require

a degree of self-imposed consistency lacking in the practical evolution of technologies for these platforms.

To this end it has been necessary to develop three strands of architecture for the project, each currently represented by collaborative working parties of Consortium and Club members: Process architecture; Technical architecture and Information architecture. A fourth group is drawing together the human, social and facilitation issues involved in the project.

Research

The project involves research at several levels. Firstly there is the identification and integration of individual groupware tools or building blocks. There is a need for basic research and development of the methodologies needed for tool integration.

Secondly there is an exercise described here as "process integration" - linking alternative packages of groupware building blocks to the information and communications needs of specific real-life business groups.

There is then a need to apply the tools to the business processes in actual organisations. A number of organisations willing to act as 'test sites' have already been identified. (The first two are the Post Office and Cheshire County Council.) An exercise based on use of groupware tools, and which can in at least some respects be repeated across sites, will then be carried out. This exercise will often involve a facilitator, as group processes in business typically are not enhanced solely by the application of technology.

Example - Market Planning

Most business use of groupware currently relates to use of a single package, or to the separate use of at most two or three different packages. The BFS involves the use, either in a single meeting, or over time, of different combinations of groupware products in a structured way.

To take, as an example currently being developed, the market planning process. This may involve several groups -the Board, the Market Planning group (cross-departmental) and the individual department management teams. It would not be unusual for each department to be supported largely by printouts from single-user spreadsheets and, to have traditional"manual" meetings to finalise proposals. The departmental spreadsheets will then be aggregated by the Marketing Strategy Coordinator. The Market Planning Group will then have "manual" meetings supported by printouts, as will the Board.

With the BFS, previously "manual" meetings will now be electronically supported. Any group involved could use networked notebook computers in a normal meeting room with a range of groupware available. Spreadsheets can be examined, but opinions about them could be annotated in different

colours (and recorded) with the Desktop Conferencing software. Brainstorming would be carried out with VisionQuest, and the results fed into a Lotus Notes database that is the available at the end of the meeting (or even during it!) for electronic publication to a much wider group.

Simulation Precedents

There are a variety of approaches which prefigured the Business Flight Simulator. A good general discussion is contained in Lane (1993).

The International Business Negotiation Simulations (IBNS) project, developed by the University of Maryland (Rawson, 1989), involves workshops which allow business executives acting as members of a mock US company, to perform a negotiation (via computer conferencing) of a business venture with their peers from an overseas country.

IMI-Geneva has developed an extensive simulation - the Integrated Management Exercise. This has no pre-digested written case study (Smiley, 1989). There is, however, a vast amount of company and industry data in a computerised information file. This "infofile", based on a real international company, includes not only the "numbers", but also narrations covering the history, background and culture of the organisation plus descriptions of the people within it.

A simulation with similar goals, Proteus, was developed by a consortium of UK universities based on a mainframe. Using funding from the UK Department of Trade and Industry's Applied Technologies in Learning Programme, Manchester Business School has developed this into a local area network based simulation - "Network Proteus".

These (as well as non-computerised games and simulations) clearly provide an important opportunities for more experiential based learning. But even these innovative approaches fall short of the concept of the business flight simulator.

Much closer to this concept is the flight simulator used to train pilots since the Second World War. These have become increasingly expensive and working with them can, for certain purposes, be deemed to substitute for actual flight experience. The flight simulator is a totally artificial environment except for the cabin unit which is a replica of the real aircraft cabin. The simulator provides external graphic displays (the view out of the cabin) which have become increasingly lifelike. A wide variety of weather and terrain options are available. There is a monitoring, recording and assessment system so that student and tutor can replay the flight and analyse what happened.

Even the most sophisticated and expensive flight simulators cannot cope with every possible situation faced, and arguably flying a plane is much more of a "programmable" exercise than running a business - there is no business equivalent of the autopilot, for example.

At the MIT Sloan School of Management, an initial approach like this has been taken with the failed airline People Express. The case developed is actually called the "People Express Management Flight Simulator". Drawing on actual company data, and a variety of planning and forecasting models superimposed on the data, students can use the computer to re-play decision making at People Express, to examine what alternative decisions might have saved the company.

Types of Simulation

In developing the BFS project a distinction has been made between two types of simulation; firstly "deterministic" and secondly "human interaction."

The great majority of simulation in both a generic and an operational research sense is **deterministic**. It contains some underlying, usually quantifiable model. This could perhaps slightly more accurately be called "model-based". The aviation flight simulator is model based. Such models can involve risk and uncertainty, but there is limited scope for exercises external to the models.

What we describe as a **human interaction** simulation by contrast is not model based. It depends on a group of people exchanging ideas and beliefs in a discussion. Alternatives may be proposed, evaluated and rejected or accepted purely through oral discussion. We have coined the phrase the "Human What-if?" to describe this.

The starting point of the BFS is the human interaction perspective. In so far as it uses model-based tools, these are supplementary inputs into the group interaction. It is possible to carry out BFS sessions with minimal or zero model-based inputs.

The Learning Organisation

There are a wide variety of styles and structures of business organisation. In order to narrow the alternative ranges of such styles and structures, a particular emphasis in the BFS is placed on the "learning organisation" (Garrett, 1989, Senge, 1990, Lessem 1992). Pedler, Burgoyne, and Boydell (1991) define the learning company as:

"an organization that facilitates the learning of all its members and continuously transforms itself."

The traditional hierarchial approach to management is, in many ways, concerned with the management of stability. However, as the environment of business changes increasingly rapidly, as the sources of competition increase rather than reduce, and as the alternative ways of managing increase, then a more flexible style of organisation needs to evolve.

The 'learning organisation' is an approach which supports such flexibility, with an emphasis on continual feedback from experience, regular review of both objectives and operations, all within a managerial philosophy with an emphasis on rich communications, both vertically and horizontally.

The majority of test sites involved in the BFS project will either have explicitly espoused the style of the learning organisation, or will have done so implicitly. However, not all organisations to be examined will fall into this category, as a control group is essential and also because in practice organisations rarely exhibit styles that are of a 'pure' hierarchical or 'pure' learning orientation. So it is essential to be able to review groups working under both styles.

Impact of systems thinking

Some of the basic concepts underlying the project are derived from systems thinking in the classical sense. One of the single most significant influences was the work of Stafford Beer (1981) in relation to warrooms or operation rooms. Beer (see Espejo and Harnden, 1989) now prefers a less militaristic term such as "management centre". To Beer, an organisation needed an information infrastructure and organisational form that were consistent with the Viable Systems Model (VSM). Data collected in sub-systems would be filtered and re-presented at the Policy and Intelligence levels.

Physically, Beer's most famous operations room was that constructed for President Allende in Chile. It is perhaps difficult in retrospect to recall the impact in the early 1970's of hearing of this futuristic room, using specially designed chairs with integral keypads, and innovative wall mounted displays.

The BFS is not attempting to replicate Beer's operations room per se. There is not as yet formal use of the VSM approach in the project, for example. But the BFS does represent an effort, using contemporary information technology, to capture some of the spirit of that room.

Conclusion

The BFS project focusses on the current and emerging needs of business to support groups in a wide variety of situations, with a broad spectrum of existing technologies. Deliverables from the project, of value to a wide variety of private and public sector organisations, are expected in each of the three years of the project.

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Appendix B
VIRTUOSI - Support for Virtual Organizations

TOMORROW'S ORGANISATION

1. DEFINING ORGANISATIONS WITHIN A VIRTUAL WORLD

THE VIRTUOSI CONSORTIUM

Dr Tom Rodden & Dr Steve Benford

Defining organisations within a Virtual World

(or how we can communicate across Cyberspace)

Dr. Tom Rodden , Dr. Steve Benford
Lancaster University
The University of Nottingham

The VirtuOSI project

BT (coordinator)
BICC
GPT
DIVISION
Nottinghamshire County Council
University of Lancaster
University of Manchester
University of Nottingham

The importance of working together

- A critical factor in organisations is our ability to work together
- Different technologies have been developed to support group work
  - email and bulletin boards
  - video conferencing
  - shared drawing and design tools
- VirtuOsi explores the potential of VR to support group work.

The potential offered by virtual reality

- supporting natural spatial skills → [illegible]
- visualising and navigating large environments
- providing direct user embodiment
- integrating multimedia

shared VR direct user involvement

[illegible] Multi media [illegible]

Potential applications

- collaborative design meetings
- meetings at a distance
- data browsing and sharing
- training and simulation

The virtual catwalk

Support for the fashion industry

Collaborative design and amendment of garments

The use of a virtual catwalk to support design

Virtual support for existing meetings

The virtual factory

- The discovery and exploitation of expertise
- Support for finding and locating others
- Support for information sharing
- Virtual meeting support of expertise groups

Key research themes

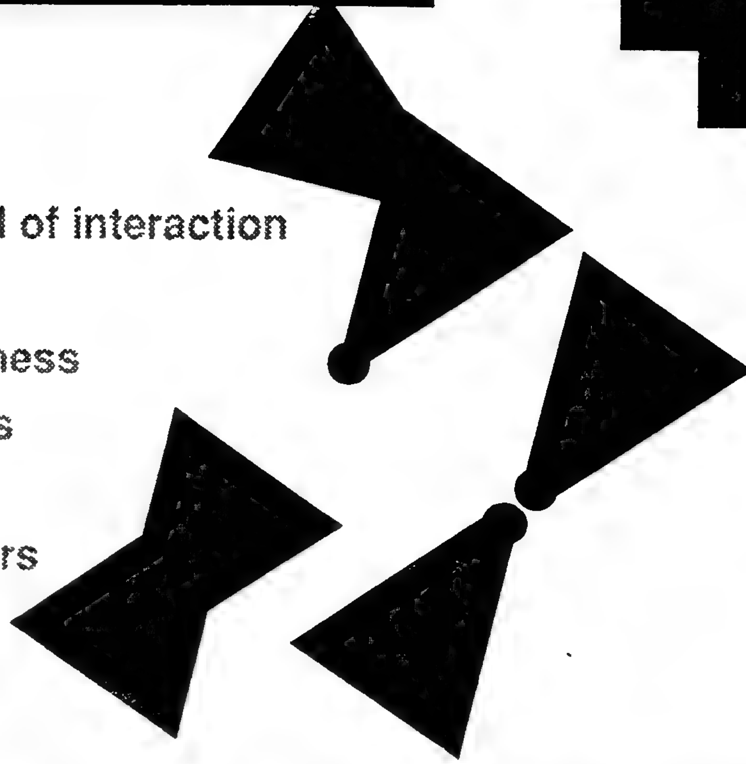
Manufacture [illegible] away at [illegible]

- user driven pilots (studies)
  - Fashion Industry
  - Manufacturing Industry

  } on-going studies
- communication
- spatial structure and navigation < develop spatial models
- distribution and communication support

[illegible] ethnography [illegible]

Conversation management



- spatial model of interaction
  - aura
  - awareness
  - nimbus
  - focus
  - adapters

From prototypes to products

- current prototypes exist in research laboratories

- real world systems
  - need experience with real users
  - large scale
  - Information Highways

Given the use,

How to use
...
potentials of Inf.
Highways

Summary

- VR can support group work
- Many key research issues, including
  - user embodiment
  - communication
- Important to be driven from prototypes to future products

Org Support w/

Gen Models for Virtual Organization

- [illegible] from real
- transition and [illegible] process, contingency
- people make [illegible]

? Virtual Organization

- [illegible]
- [illegible]
- [illegible]
- [illegible] support
- [illegible]
-

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THE VIRTUOSI PROJECT

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Tom Rodden, Lancaster University
Michael Rygol, Division Limited
Vaughan Stanger, GEC-Marconi Hirst Research Centre

1. INTRODUCTION

Virtuosi is a major UK project to explore how virtual environments can be used to support cooperative work across distributed real organisations. Its main aim is to develop a sound framework for constructing CSCW (Computer Supported Cooperative Work) systems that integrates our emerging understanding of natural and effective social structures with the state of the art in virtual reality, multimedia communications and distributed systems. This framework will be evaluated within two large pilot applications, one distributed across cables development and manufacturing sites in several countries and the other in the fashion industry. The project will also contribute towards new methods for analysing, deploying and evaluating such systems.

Virtuosi will exploit and extend models of cooperation in virtual space which are emerging from a number of European projects including COMIC, the ESPRIT Basic Research Action into CSCW [Benford 93a]; the RACE MITS metaphor development project and the RACE BRICC multimedia user interface pilot project [Leevers 92, Leevers 93]. These projects are all concerned with spatial approaches to cooperative systems and the resulting models provide key concepts for supporting conversation, navigation and interaction within structured spatial settings. The technical infrastructure for the project will be provided by DIVISION's dVS [Grimsdale 93a, Grimsdale 93b] combined with multi-media and distributed systems technologies provided by BT and GPT Limited. This combination of theory and technology should enable the construction of large shared and distributed virtual environments - virtual organisations.

The project will be validated through two pilot applications. The first is the Virtual Factory, involving the construction of a large CSCW environment spanning a set of distributed cable making factories owned by the BICC group. This pilot will explore the problems of promoting awareness, holding meetings, training and trading expertise in a large distributed environment over extended time periods. The second, Fashion Design and Brokering, explores support for collaborative design, marketing and negotiation within the fashion industry. This pilot will centre on the idea of a shared design space, the Virtual Catwalk, around which fashion designers and buyers will negotiate designs. The results from the pilots

will be unified through a common framework which will provide generalisable techniques for constructing future CSCW systems. The framework will address models and metaphors of interaction in virtual environments; an open reference architecture for such environments related to emerging distributed processing platforms; and methods for analysing and evaluating CSCW systems. These results will also be input to relevant international standards.

Virtuosi is funded under the DTI/SERC CSCW programme and involves the following partners: BT, DIVISION, GPT, GEC-Marconi Hirst Research Centre, BICC, Nottinghamshire County Council and the Universities of Lancaster, Manchester and Nottingham. The goal of this paper is to introduce the Virtuosi project and to summarise its main objectives (section 2). Given the early stage of the project (work started at the end of 1993), it is not yet possible to present any concrete results. However, some of the background work that will be driving the project is also briefly summarised in section 3.

2. OBJECTIVES

This section presents a more detailed overview of the work to be carried out within Virtuosi over the next three years under the headings of models and metaphors, infrastructure and architecture, methods and the two application pilots.

2.1. Models and metaphors

Virtuosi will address the following theoretical issues concerning the relationship between group work and distributed virtual environments:

Applying new models of conversation and interaction in virtual space. These models define techniques for managing conversations (i.e. controlling turn-taking, joining and leaving) as well as for managing general interactions with objects in space (e.g. non-direct manipulation techniques for controlling action at a distance). Such models will support users in direct communication with each other over varied media (both synchronous and asynchronous) and also in having peripheral awareness of the presence and activity of others.

Developing appropriate embodiments of users. The aim here is to identify key properties of virtual bodies for conveying aspects of cooperative work such as degree of presence, activity, availability, gesture, involuntary expression, viewpoint, identity, personalisation, truthfulness and others.

Techniques for representing and navigating virtual organisations. The representation question hinges on a choice between the use of real world metaphors such as rooms, corridors and buildings against more abstract "information terrains" to provide a large virtual structure for co-operative work. Support for navigation might include the provision of maps, signposts, trails, tours, guides and histories.

2.2. Infrastructure and architecture

A long term aim of Virtuosi is to specify a general reference architecture for distributed CSCW virtual environments based on the experience of constructing the application pilots. This includes the following.

Enhancing distributed object models to support highly dynamic and reactive virtual environments. Topics of relevance include flexible trading and request brokering, management of multi-cast protocols and distributed collision detection in large environments. This may also require the extension of world description formats for the exchange of world data across such platforms.

Analysing communications requirements for distributed virtual environments such as bandwidth limitations and the impact of latency. These issues will be considered in the light of practical experience with several communication mechanisms including ATM, ISDN and Ethernet. This will also involve considering the relationship between virtual environments and more traditional conferencing media such as video.

Mapping the Virtuosi infrastructure onto emerging standards for distributed systems such as the International Standards Organisation's ODP, The Object Management Group's OMA and The Open Software Foundation's DCE, resulting in a general reference architecture and also input to these standards bodies.

2.3. Methods

The construction of virtual environments to support group work needs to be informed by a clear understanding of how cooperative work is actually carried out in a given setting.Virtuosi will therefore generate and refine techniques for carrying out the analysis of work and the development, deployment and evaluation of CSCW systems. This includes the following work:

An assessment of different techniques for understanding the nature of CSCW systems. These include participative approaches, task and organisational analysis, traditional systems analysis and observational techniques from social science. Furthermore, this work may require the extension of existing requirements capture techniques to incorporate data derived from observational studies; the development of guidelines for managing the organisational impact of CSCW systems deployment; and the development of techniques to manage the assessment and evaluation of CSCW systems.

2.4. The Fashion pilot

This pilot is concerned with supporting the process of collaborative design, marketing and brokering of clothing designs in the fashion industry. Results from this pilot should also generalise to other design environments. The eventual aim of the pilot fashion-brokering service will be to bring together designers and buyers across wide area computer networks in order to negotiate designs and orders. The

initial aim of the pilot will be to establish two terminals for designers and manufacturers in a resource centre at Nottingham linked to one for buyers in London. It is hoped to link this system to an additional terminal for buyers in mainland Europe by the end of the pilot. The pilot system will also be integrated with existing CAD packages which are currently used for clothing design and will also incorporate on-going work into the visualisation of fabrics and designs.

Collaborative design has proved to be a challenging issue for CSCW. The fashion pilot will extend this work in several ways. First, design objects will be visualised and manipulated in three dimensions. Second, the designs will be both animated and highly realistic (e.g. using moving mannequins and textured fabrics). As opposed to having fixed viewpoints, several designers will be able to move around the designs at will discussing, annotating and changing them in real-time. In effect, the pilot will construct a "virtual catwalk" around which discussion can take place. Thus, group support will focus on problems of visualisation, sharing, negotiation and discussion (e.g. adding new features or even changing properties of the mannequin - "what would it look like in these measurements?"). Discussion will be supported through audio communications, annotation and note taking.

2.5. The Factory pilot

BICC Cables consists of a large number of medium sized factories in several countries. It is therefore often necessary for BICC colleagues to communicate both in this country and abroad, on a daily basis, particularly to carry our training, trading of expertise and troubleshooting. This communication often involves much expensive and time-consuming travel.

This application pilot intends to extend current work on multi-media communications at BICC to provide an integrated *virtual BICC organisation* that allows technical and manufacturing staff throughout the world to trade expertise and technology and to support training (particularly in terms of introducing a culture of Continuous Improvement while exchanging Best Demonstrated Practice between different manufacturing groups) without the overhead of extensive travel. In essence, this pilot will focus on the issues of representing and navigating large organisational structures, promoting awareness within distributed organisations, establishing contacts with collaborators, trading expertise and training, and arranging and holding meetings.

3. BACKGROUND

We now briefly present some of the background work that has taken place between various Virtuosi partners which will drive the early stages of the project.

3.1. The COMIC project

COMIC is the European Basic Research action into CSCW funded under the CEC's ESPRIT programme. COMIC involves nine European research laboratories, including Lancaster, Manchester and Nottingham Universities. The

overall goal of the project is to develop core theories to support future European CSCW products. One aspect of the COMIC work concerns spatial approaches to CSCW, which includes theories to support cooperative virtual environments. So far, the major result to emerge in this area has been a so called 'spatial model of interaction' for large virtual environments [Benford 93a]. This model provides a base set of mechanisms for supporting conversation in crowded virtual spaces, including the following concepts:

Aura: a subspace surrounding an object which limits the scope of its presence in virtual space [Fahlén 93a]. Prior to aura collision, two objects have no knowledge of each others presence. When collision occurs, they gain the potential to interact via some system action such as an exchange of addresses, interface references or the establishment of some network association.

Awareness: once auras have collided, the notion of awareness is used to control the flow of information between objects. In essence, the more that one object is aware of another the more information it receives from it.

Focus and nimbus: mutual levels of awareness are controlled through focus and nimbus [Benford 93b]. A focus is a subspace within which an object is directing its attention. A nimbus is a subspace within which it directs its presence or activity. The awareness that object A has of object B is then a function of A's focus on B and B's nimbus on A. Objects subsequently move around space using their foci and nimbi to control their interactions with each other via awareness.

Adapters and boundaries: Most often aura, focus and nimbus will be manipulated implicitly though actions such as moving and turning in space. However, explicit manipulation may be possible through the use of adapter objects which alter aura, focus and nimbus fields. Example include virtual podia (nimbus amplifiers) and virtual tables (which fold foci and nimbi into a common subspace for more private conversations). Boundaries are specialised adapters which constrain and transform both movement and awareness across space.

Early prototype implementations of this model have been demonstrated within the DIVE Distributed Virtual Environment by researchers at the Swedish Institute of Computer Science [Fahlén 93b].

3.2. dVS

dVS is a runtime environment for virtual reality applications developed by DIVISION Limited. dVS runs on a range of platforms and has been designed to support the computational demands of interactive virtual worlds allowing applications to move between platforms unchanged. Virtual reality systems require enormous computational power. dVS addresses this problem by sub-dividing the overall simulation into a number of discrete parallel components, called Actors, which control different aspects of the system. These servers run concurrently with application programs so that visual and audio feedback resulting from sensor

supplemented by tools to optimize and reduce the complexity of the geometry files produced.

3.3. The Computerised Fashion Show

The use of 2D CAD/CAM tools is being exploited across a number of areas in textile and clothing design. The technology is being adopted by a number of companies as their standard design method and work at Nottingham Trent University is pioneering the integrated use of these tools in industry and academia for design, production and retail. One of the packages used in the system (Ormus Fashion) was co-written by Stephen Gray, a consultant to the Virtuosi project.

3D technology has yet to be used by the clothing industry, primarily due to the mathematical problems associated with the accurate representation of "drape". Moreover the lack of suitable tools make the concept alien to most fashion designers. A project to develop the "Computerised Fashion Show" is currently being undertaken in a multi-disciplinary team linking fashion designers with computer scientists and mathematical modellers. The initial development work [Gray 93a, Gray93b] has been used to demonstrate the principles of dynamic mannequins and deformable materials to the industry.

The modelling techniques currently under development integrate physical characteristics with dynamics and surface representation. The use of methods such as these were employed in the making of the film "Jurassic Park" and they are slowly migrating to the Virtual Reality environment.

3.4 The Fashion Information Service

Nottinghamshire County Council is currently sponsoring the development of an interactive multi-media database to provide the local clothing and textiles industry with a variety of information services in graphical form. The telecommunications infrastructure in the county is being used to link clients with the central hub housed within the Fashion and Textiles department at Nottingham Trent University.

The evolution of this system is based on trials with five pilot companies, most of which already employ CAD/CAM techniques. The provision of data transfer facilities between the database and a variety of packages is enabling a more integrated approach to the use of IT services in these companies In turn this will provide the first demonstration harness for the Virtuosi project using the infrastructure to provide the basis for an interactive dialogue (or brokering service) based on the information available on the system.

3.5 Virtual reality research at GEC-Marconi Hirst Research Centre (HRC)

A programme of research into the concepts and applications of virtual reality was established at HRC in April 1991, following on from earlier work on the use of 3-

inputs (head movements, gloves, etc.) is application independent. The design of dVS allows these Actors to be distributed over a number of processors, if available, communicating via a distributed, shared database called VL.

The fundamental object in the VL database is an "Environment", a shared data space which can be accessed by a number of actors. The Environment contains strongly typed objects called "Elements". Actors create an "Instance" of an Element to store specific "State". These instances are then available to all Actors on a need-to-know basis. An Actor which has access to an Instance is said to "Hold" that Instance. In order to change an Instance, an Actor "Extracts" a copy, makes a local change and then commits this change to the Environment with an "Update". When the state of an Instance is changed by an Update, each Actor which currently Holds that Instance will receive an "Event" which informs it that a change has occurred. This structure allows the rapid development of user applications which are portable across a range of platforms and are able to exploit the computational resources of each platform. A standard set of actors is provided with dVS:

1) VIZ provides a visual display of the virtual world in either a fully immersive or desktop environment.

2) VSOUND is a real-time acoustic server which provides generic sound synthesis and 3D spatialisation.

3) TRACKER provides support for a range of 3D tracking devices. It creates a homogenous tracker output which allows development of device independent applications.

4) BODY represents the user in the virtual environment. It creates and animates the virtual body and defines the way in which the participant interacts with other objects in the world.

5) COLLIDE is a collision detection server which constantly monitors objects within the world for possible intersection.

dVS applications use the functionality provided by the VC Toolkit, a collection of high-level C routines used to create and manipulate the visual, acoustic and physical properties of virtual objects. Alternatively, users may rapidly build and experience virtual worlds with dVISE, a high-level tool which creates visual and acoustic simulations of defined virtual environments. dVISE has been designed to allow multiple users to concurrently share and modify the same environment. The user may wander around the environment picking up objects and manipulating their properties. In addition, dVISE allows the user to author additions to the world, adding and placing new objects. An X Windows (Motif) interface to the virtual world is provided by means of XdVISE. A set of converters are provided to convert from most standard CAD formats to allow the user to immerse themselves in data provided by commercial CAD packages. These converters are

D models for image compression. Conceptual work at HRC has explored the use of multi-scene virtual representations of telecommunications networks, including the embedding of users and their applications within such a representation [Stanger 92]. The animation and texture mapping of user representations in virtual environments has also been examined [Stanger 91]. Applications which have been evaluated include telecommunications network management, multi-user collaborative environments, simulated vehicle training, education and leisure, tactical command and control, and medical data visualisation. Examples of all of these applications have been implemented for demonstration purposes on a ProVision immersion VR system, obtained from Division in 1991. This implementation work has emphasised the construction of run-time user tools and other "intelligent" virtual objects.

A strong theme of HRC's current VR research work is the evaluation of the feasibility of supporting multi-user VR applications, such as CSCW, on current and planned telecommunications networks. Studies of the time-series properties of VR data have already been performed [Stanger 93], and will be extended in the Virtuosi project. Another area which HRC expects to address in the near future is the integration of voice input into virtual environments, thus providing users with a "hands-free" form of interaction capability.

4. Summary

Virtuosi is a three year project investigating support for cooperative work in virtual environments. The project involves four UK companies, three universities and one local authority and is funded under the DTI/SERC CSCW programme. This paper has provided an introduction to Virtuosi, stating its objectives and presenting some of the background work that will drive its early stages. The major objectives fall in the areas of models and metaphors for collaborative virtual environments, architecture and infrastructure for distributed VR systems and methods for analysing, deploying and evaluating such systems. We look forward to reporting the results of this work as they emerge over the next few years.

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[Fahlén 93a] Lennart E. Fahlén, Charles Grant Brown, Olov Stahl, Christer Carlsson, *A Space Based Model for User Interaction in Shared Synthetic Environments*, in Proc.InterCHI'93, Amsterdam, 1993, ACM Press.

[Fahlén 93b] Lennart E. Fahlén, *Virtual Reality and the Multi-G Project*, in Proc. VR 93, London, April 1993, Meckler.

Appendix C
SYCOMT - System Development and CSCW: Methods and Techniques

TOMORROW'S ORGANISATION

3. SYSTEM DEVELOPMENT & CO-OPERATIVE WORK

THE SYCOMT CONSORTIUM

John Williams

SYCOMT

SYCOMT
- ensuring groupware delivers benefit to cooperative work.

John Williams

Digital Equipment Company Ltd

SYCOMT

IT Investments So Far

"Studies of organisations over the last 20 years show that there is no correlation between IT spend and corporate profitability."

Paul Strassman
The Business Value of Computers

SYCOMT

Why Has This Happened ?

- confusion & misunderstanding
- dificulties in articulating needs
- organisational complexity
- unexpected uses
- vested interests
- irrational buyer behaviour
- ....

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Could Things Be Different ?

Potentially, because:-

- We know technology alone won't solve things
- The technology is sufficient for our needs
- We have some new, non-traditional tools that will help us to understand users & their needs better
- New development methods offer iterative evolution for solutions

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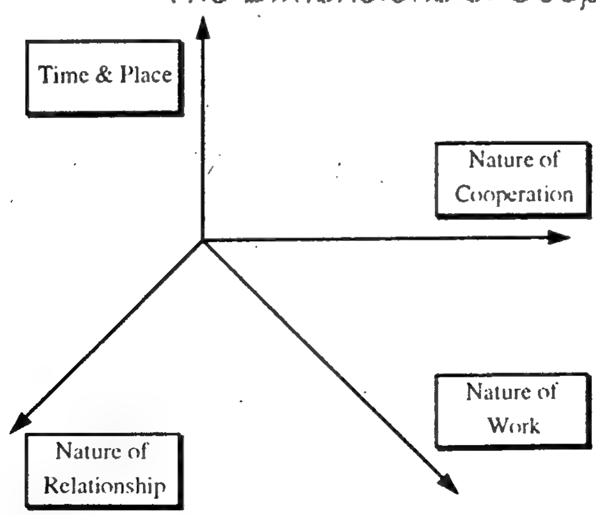
Potential Pitfalls in CSCW

- assumptions on what is being automated
- assumptions on user involvement
- bringing I.T. overheads to the office
- focussing on process not product
- blurring of organisational boundaries
- over segmentation of work
- creating automation islands
- getting management buy-in

SYCOMT

What is Cooperative Work ?

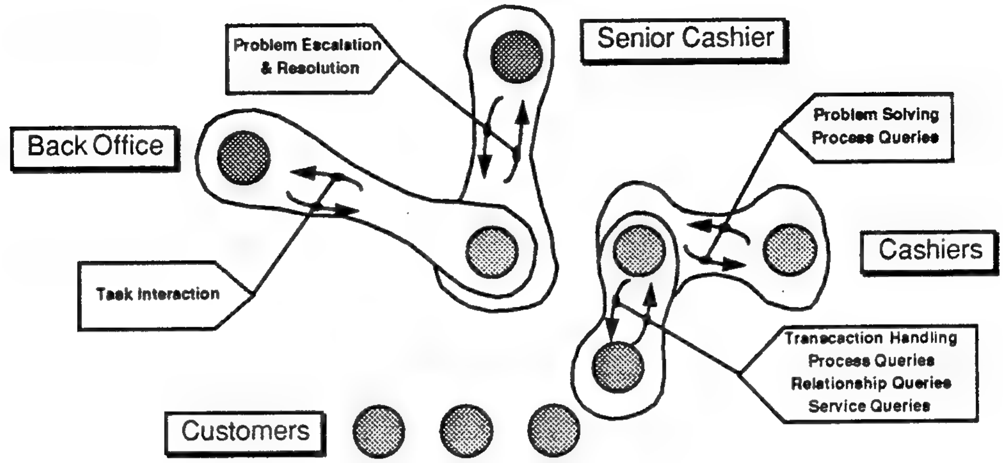
The Dimensions of Cooperation



SYCOMT

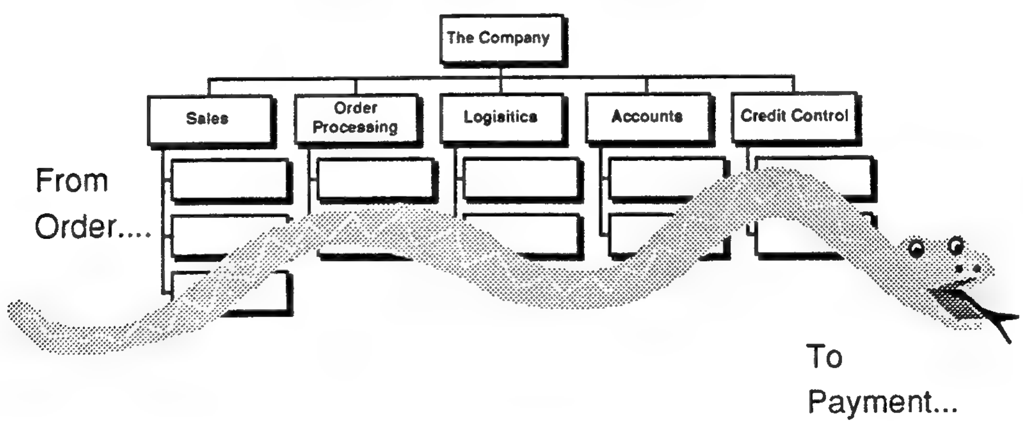
What is Cooperative Work ?

Co-operation in Branch Banking



SYCOMT

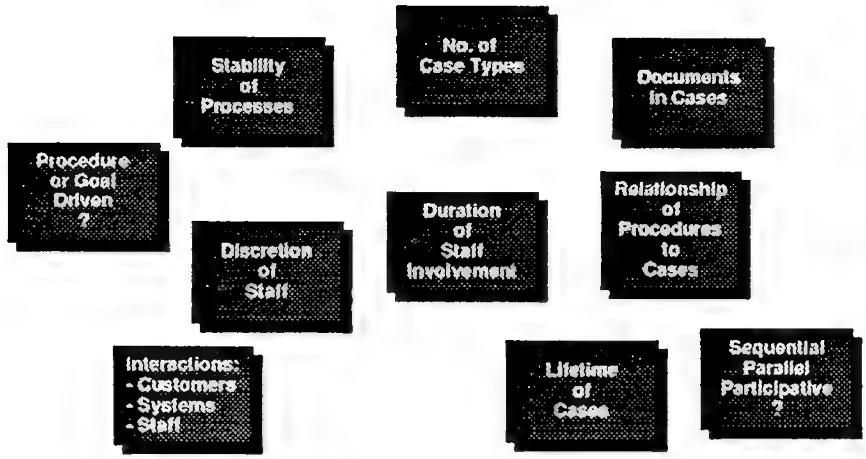
Process Versus Hierarchy



"The process is not the organisation......"

SYCOMT

The Importance of Work Styles



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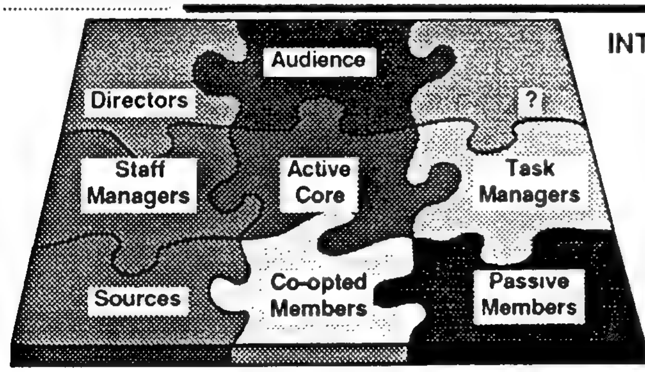
What is a Group ?



INTERNAL

XINTERNAL

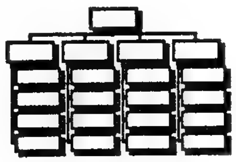
IXTERNAL

EXTERNAL

SYCOMT

The Origins of SYCOMT

Business Model Vs Reality



CASE techniques have been used to develop a Model that supports business re-engineering in retail banking. It places great emphasis on care for customers.

Have the techniques been well applied ?

Does the Model adequately reflect the realities of customer service ?

SYCOMT

The Origins of SYCOMT

Business Model Vs Reality

- Environment
  - U.K. Building Society
  - Branch Cashier Operations
  - Mortgage Application Processing
- A New Method - Ethnography
  - Observations in branch & office
  - Carried out by University of Lancaster, Department of Sociology staff

SYCOMT

The Origins of SYCOMT

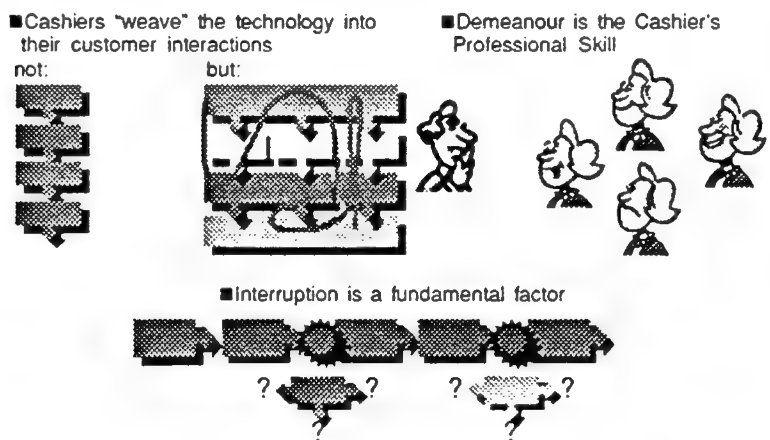
Ethnography ?

- An observational technique
- Looks at the real world
- Descriptive
- People in their work context

"Work fascinates me, I could watch it for hours."

SYCOMT

Pilot Study Findings



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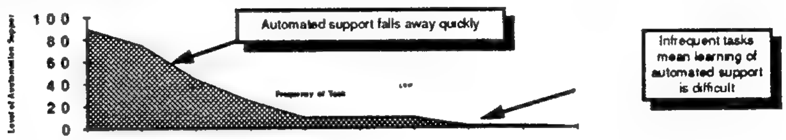
Pilot Study Findings

- Co-operative work is a feature of all roles

- Duplication & gaps between activities

- Conventional automation only hits the most frequent tasks and usage/familiarity trade-offs condition the utility of automation

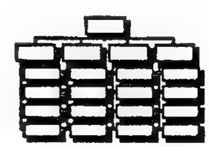


SYCOMT

The Origins of SYCOMT

Lessons from the pilot study

- Model: Consistencies, Extensions & Conflicts
- User Aspects: HCI, Processes, Organisation
- Showed new techniques (Ethnography) could give valuable input to complement a traditional view.
- Showed the need for other techniques such as Managerial Cybernetics



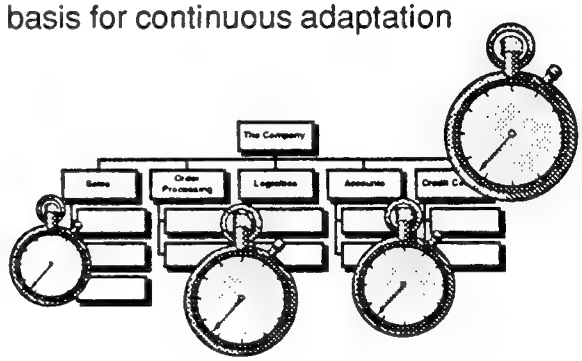
- Demonstrated the need for:-
  - careful analysis
  - reviewing subjective data
  - translation to actions

SYCOMT

The Origins of SYCOMT

Managerial Cybernetics ?

- a technique for creating "viable organisations"
- supports empowerment while retaining focus and cohesion in the organisation
- establishes the basis for continuous adaptation



SYCOMT

The SYCOMT Project

- Systems Development and Cooperative Work:- Methods & Techniques
- Objective:- investigate, prototype, test and evaluate methods and business systems that will:-
    - help businesses capture the needs of those who work in groups
    - help those intending to empower staff through devolved responsibility.
    - help companies to assess what groupware can and cannot do.

SYCOMT

What Will SYCOMT Deliver ?

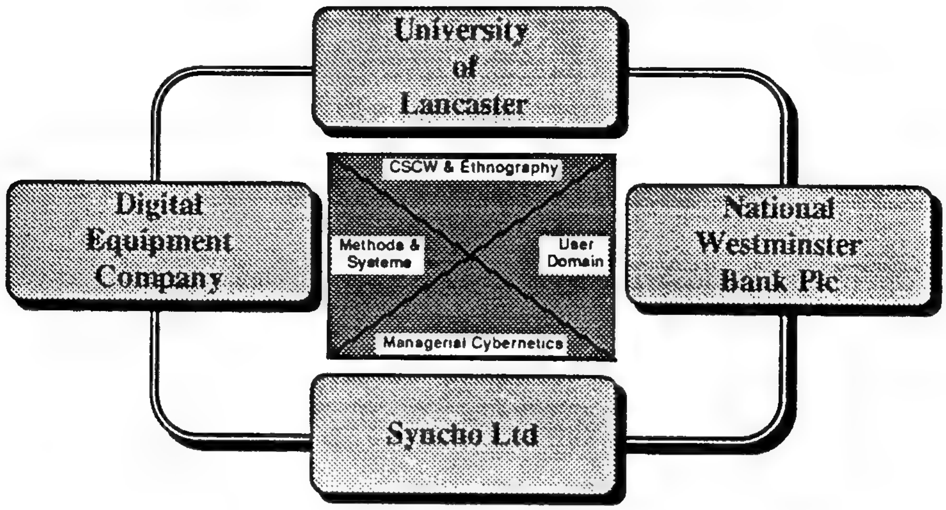
- a **clear definition** of CSCW and the infrastructure needed
- a **review** of available technology
- **methods** and **metrics** for analysing how groups work
- a broad **methods framework** for systems development
- **tools** to support the method(s)
- an understanding how **ethnography** and **managerial cybernetics** contribute to the development of groupware
- **services** so that companies can use these techniques.

SYCOMT

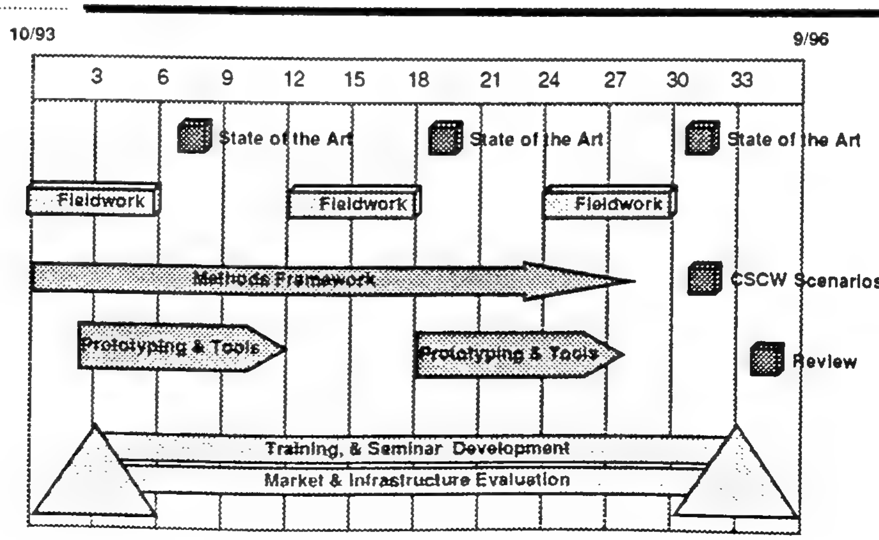
Approach

- study real-world activities using ethnography and managerial cybernetics:
  - banking work in both customer-staff and staff -staff cooperations
  - cooperative work in strategy formulation
  - management control of distributed functions
- test and review CW systems with and without computer support
- use the same study techniques to review changes, benchmark and show benefits
- test market our findings

SYCOMT Partners



SYCOMT Goals



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Progress To Date

- Pilot Summary Available
- First fieldwork studies completed:
  - branch banking, ethnographic study of a "traditional" branch
  - branch banking, cybernetic study of a "new style" branch.
  - 2 x 1 week studies
  - Initial reporting : Feb '94
- Follow-up fieldwork & analysis in progress

Behaviour in Training different from real life

SYCOMT

Progress To Date

Ethnography Results - Pointers

- Issues in introducing the "selling culture"
  - training versus real life
- Expertise & customer query handling
  - automation support & workplace ergonomy
- Work management
  - *"all it encourages is swearing as far as I can see"*
- Teamwork & local knowledge
  - "constellations of assistance"

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Progress to Date

Ethnography - Ideas & Application

"Mind the Gap...."

"Dependancies"

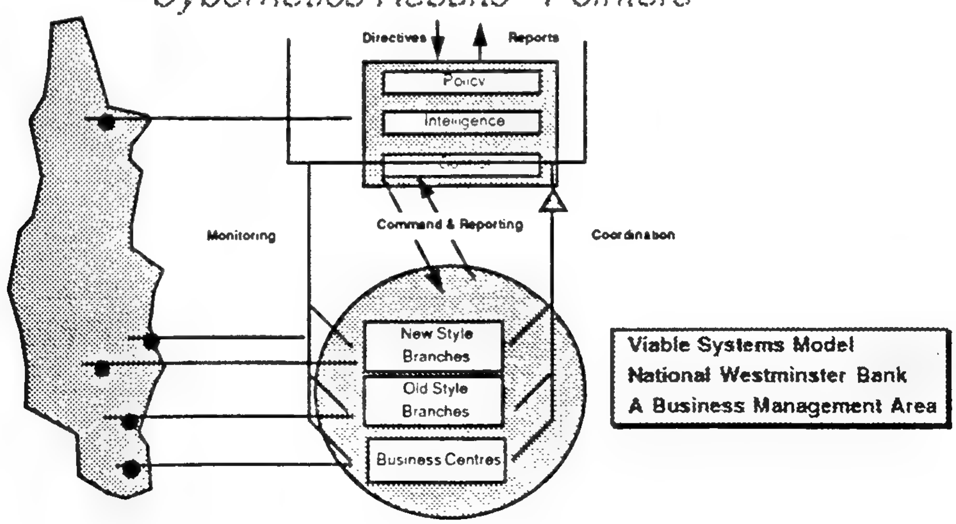
"What Makes a Good.....?"

"Vengeful & Benevolent Gods"

SYCOMT

Progress To Date

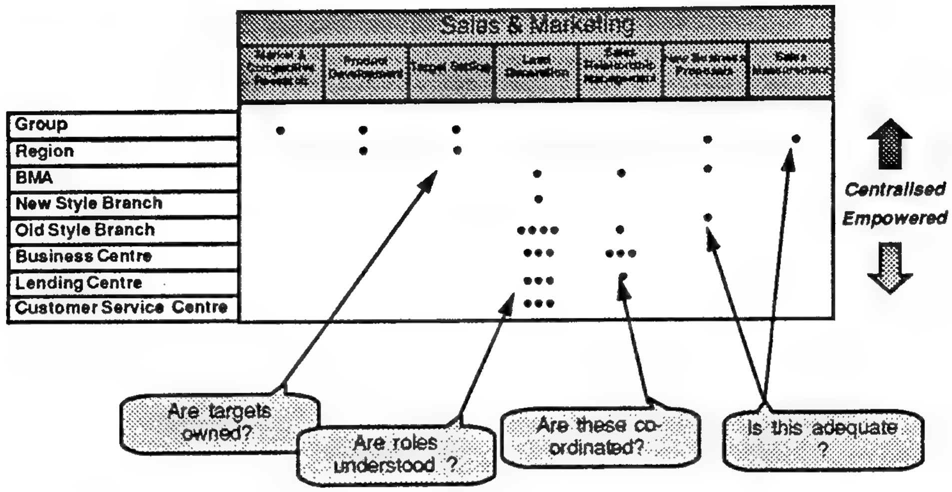
Cybernetics Results - Pointers



SYCOMT

Progress to Date

Cybernetics : Unfolding Complexity



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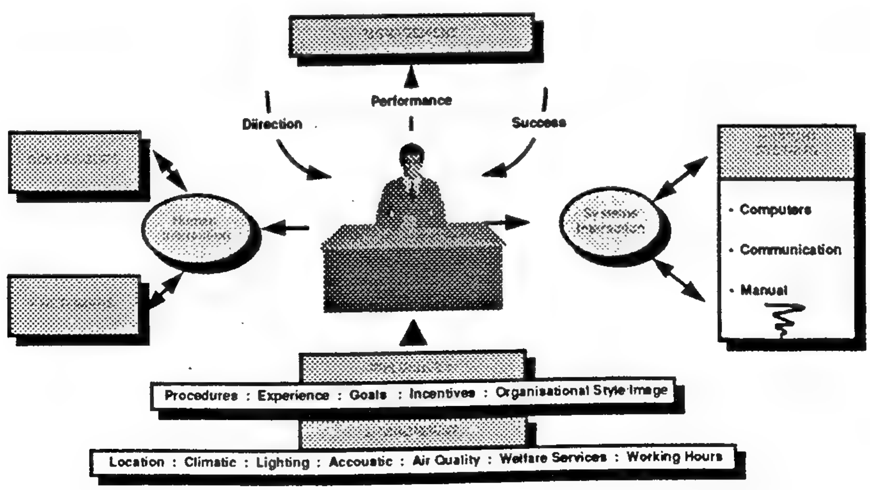
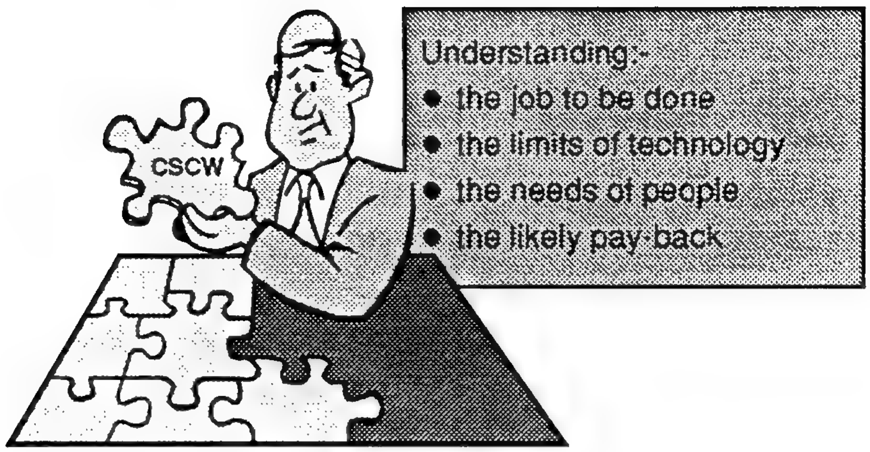
Organisations & CSCW

Combining Cybernetics & Ethnography



SYCOMT

Safer CSCW Investment



SYCOMT

System Development and Cooperative Work: Methods and Techniques

Syncho Ltd

National Westminster Bank Plc

Digital Equipment Company Ltd

University of Lancaster

SYCOMT

System Development and Cooperative Work: Methods and Techniques

Working Together

Management Summary of CSCW

Geoffrey Darnton

Incorporating contributions from:

Steve Blythin (Banking)
Raul Espejo (Managerial Cybernetics)
John Hughes (Ethnography)

SYCOMT Occasional Paper No. 1 - May 1994

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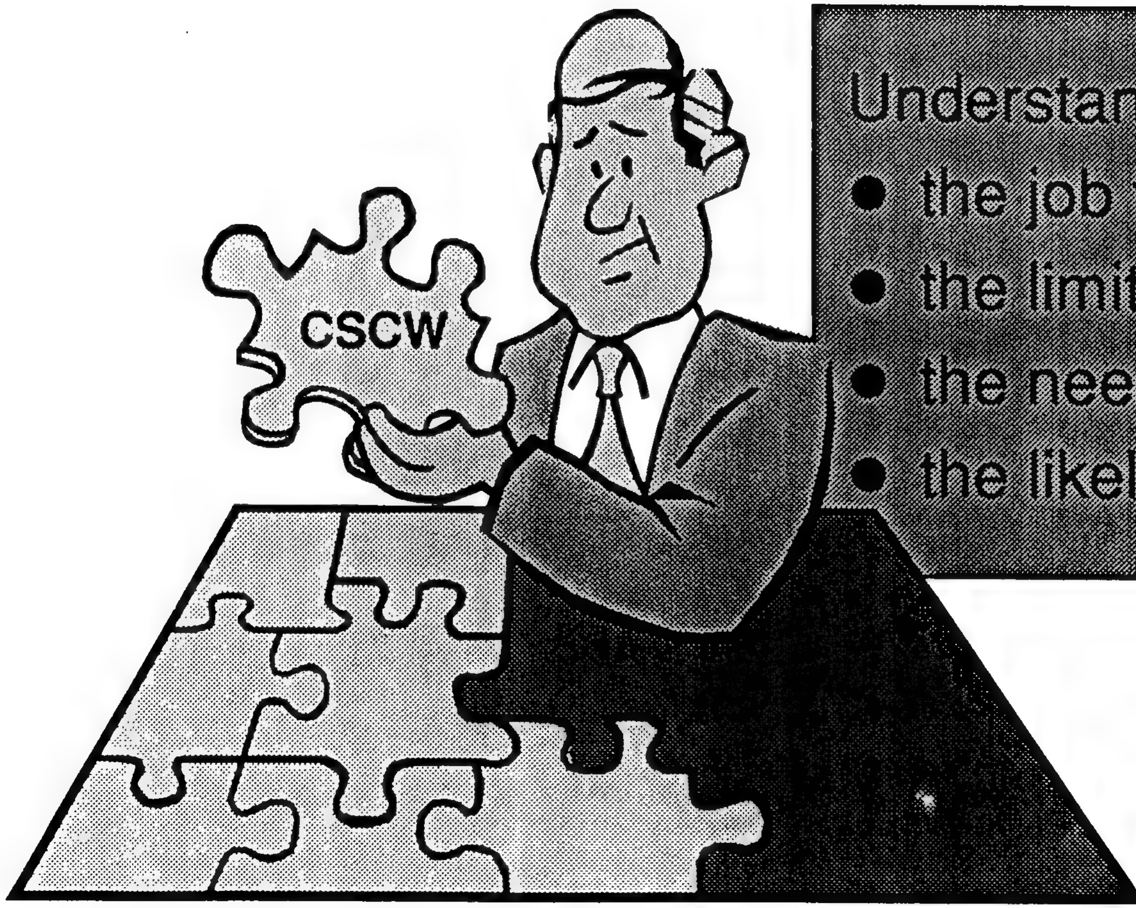
SYCOMT

Safer CSCW Investment



Understanding:-

- the job to be done
- the limits of technology
- the needs of people
- the likely pay-back

Working Together: A Management Summary for CSCW

Geoffrey Darnton

incorporating contributions from Steve Blythin (Banking), Raul Espejo (Managerial Cybernetics), and John Hughes (Ethnography).

This document is SYCOMT Occasional Paper No. 1. It has been issued to provide an overview of SYCOMT, and coincides with the DTI CSCW Launch event, *Tomorrow's Organization*, London, 10th and 11th May, 1994. It highlights the main themes of SYCOMT and explains the very broad basis of CSCW that is incorporated into the Project.

This is a summary extracted from a more substantial document *Working Together: A CSCW Primer* that will be published later in 1994.

SYCOMT brings together very original contributions from fields as diverse as applied ethnography, managerial cybernetics, and organizational and business modelling to an understanding of cooperative working. These are terms that are neither readily understood by the public at large, nor indeed by business management. This Occasional Paper presents an outline of the key approaches and their usefulness in a wide range of situations.

SYCOMT Consortium and Project

SYCOMT (*System Development and Cooperative Work: Methods and Techniques*) is a collaborative research Project that brings together four world-class organizations into a Consortium to explore and expand the frontiers of Computer Supported Cooperative Work (CSCW). The Consortium members are described at the end of this document.

SYCOMT combines the talents of

- Digital Equipment Company Ltd., the UK arm of Digital Equipment Corporation
- Lancaster University's Departments of Sociology and Computing
- National Westminster Bank Plc.
- SYNCHO Ltd.

Geoffrey Darnton is a Principal Business Consultant with Digital Equipment Corporation and Adjunct Professor of Information Economics at the European University (Geneva), Steve Blythin is a Project Manager with National Westminster Bank Plc., Raul Espejo is Managing Director of SYNCHO Ltd. and Head of the Information Management Group at Aston University Business School, and John Hughes is Professor of Sociology at Lancaster University.

The research Project runs formally for three years between 1993 and 1996 and aims to contribute to the emerging understanding of how computer technology is used (and could be used) in support of people who need to work together.

Working Together

The 1980s saw a great deal of new management literature on the subjects of competition and competitive strategy. However, a bias towards individual and group competitiveness risks losing sight of an age-old feature of work which is that on so many occasions all of us need to work collaboratively with others. Some attention now needs to be given to understanding the real nature of work, to inform the explicit design of organizations and new ways of working.

There are many important reasons why people need the help and cooperation of others if they are to achieve their objectives (personal or professional). Organizations are being set up to perform tasks of increasing novelty and complexity. In addition to meeting work objectives, cooperative working can provide people with a satisfying psychological and social environment—a factor that should be taken

into account when designing organizations or organizing work. It is all too easy for programmes such as business process re-engineering (or innovation or improvement) to place a great deal of emphasis on such things as process and information flows (or the technology to support them), without paying proper attention to the social organization of work or the social needs of people at work. New applications of technology make it possible to change dramatically the distribution of tasks and responsibilities in a company but if social factors are not considered in the design and implementation of new systems then the cure may prove worse than the disease.

At the present point in the Project†, we are looking at five particular categories to describe ways in which people work together.

1. Common Task

This category covers people working together in a group to produce some product or service, or perform some activity. There are many examples of this kind of situation.

In the arts and sports world there are groups such as orchestras and teams that must work together for a satisfactory result.

In the business world, senior decision makers and consultants may work together to produce an enterprise strategy; or a team of people may work together to determine how to identify and manage risk associated with a large loan.

In the engineering world, a group of different specialists may collaborate to design a machine, such as a computer, a car, an aircraft, or a new building.

In the production world a group of people may work together mining coal or building a factory.

This kind of collaborative situation is sometimes referred to as a *workgroup*–a group of people put together for a specific set of objectives.

2. Sequences of Tasks

People may need to collaborate together in a "chain" of activities. One person or group finishes one phase of work, and then the work passes to another individual or group, until the whole product or service is finished.

Most manufacturing and trading companies have order fulfilment as a core objective of the business. Many people may be involved in a complex set of chains of events in providing the various services for someone to travel from one country to another. Purchasing a building may need the cooperation of a sequence of teams involved in survey, negotiation, finance, and legal work.

This kind of collaborative situation is sometimes referred to as *workflow*.

3. Problem Solving

Multi-disciplinary teams, and multi-skilled teams work together to solve many different kinds of problem.

For example, a team of medical specialists may need to pool its knowledge to help someone who is seriously injured or ill. A house is made using a wide range of building skills. A complex information system needs people with business, operations, managerial, and technical skills to handle everything from thinking about the system that is needed, to creating one and using it.

Many enterprises are attempting things of such complexity or novelty that they have not yet been done before. This means that often there is no direct experience that can be used for a new project. Ideas and approaches may benefit from being "brainstormed" by a group of people with very different backgrounds.

Many consulting companies have found that cooperative working by multi-disciplinary teams can be very effective in determining the approach to be taken for a difficult problem where the solution is not obvious at the outset.

4. Command and Control

Command and control operations frequently require collaborative work. For example, in flying an aircraft from one place to another, there is not only the cooperative work in the air traffic control centre, but also cooperation between air traffic control and the pilot, and between the crew in the cabin of the plane.

Human beings may be used to overcome limitations of technology. For example, in armaments control systems, humans are often left in the control loop because it is not appropriate to make decisions entirely automatically.

Many enterprises around the world are "downsizing" in terms of organization, management, and technology. This may mean "empowering" more people so decisions can be taken locally. Technology may be distributed to support the various locations of decision making. When this happens, how does the enterprise know that it is still in "control"? Are the communications channels sufficient to handle

† As SYCOMT is a research Project, this list of categories may change as results are produced.

the flows needed to implement the organizational design?

5. Mutual Aid

People come together to cooperate for other reasons. A customer and supplier, or client and professional, rely on each other for mutual benefit. When someone takes a loan, the individual assumes a benefit from the use of the money, and the financial institution assumes benefits on its profit and loss account, and balance sheet.

A group of people may be formed on an *ad hoc* basis to solve a particular problem. For example, members of a town or village may come together to decide how to respond to some planning proposal. Someone may call a meeting to pool ideas about how a particular problem could be approached. Researchers in a particular field of study may exchange papers, hold conferences, and share proceedings in order that everyone can benefit and contribute to progress.

SYCOMT Approaches

Many of the concerns addressed by SYCOMT arise from the rapid deployment of technology in general, and information technology–specifically computer-based technology–in particular.

The information technology world has seen some massive swings. First there was a gulf between centralized data processing operations using mainframes, and control of machines using local dedicated machines. Then, millions of personal computers (PCs) were deployed world-wide, in part because the larger on-line systems could not meet the needs of many computer users. Now there is a recognition that although the development of the computer (as used by people, not built into machines) was addressed mainly at the individual worker level, in fact so much work really requires people to work together collaboratively.

Here we are in the middle of 1994 with a major trend of linking systems together in "client-server architectures" that can support people working together. The emergence of the Internet and the so-called "information super-highway" offer the potential for electronically-based teams to emerge spanning geographic and organizational boundaries.

SYCOMT is based on a belief that in part, the kind of technology to support collaborative working may well be very different from the technology currently used. First, however, we must understand how people and enterprises collaborate in their work—and we are basing this on ethnography, managerial cybernetics, and novel approaches to modelling and analysis. *

The key questions are:

- The informal and social dimensions of work are very important for effective organizations. Many people understand that working well is often dependent on informal rather than formal contacts. At work, very often words, approaches, background, culture, and so forth are taken for granted. How significant are these informal dimensions of work? SYCOMT is approaching this issue by applying techniques from ethnography.
- There is widespread recognition that large organizations do not function well with bureaucratic hierarchical management structures and there is a substantial movement towards flatter, distributed, responsibilities and management. How can distributed, empowered, entrepreneurial groups be fostered while achieving a set of overall enterprise objectives? Techniques from managerial cybernetics are being used to address this question?

Co-opWare Technology

In the many existing cases of cooperative work, we are finding that much computer technology has been introduced in recent years. Hence the introduction of the term CSCW for computer supported cooperative work.

There is a term that was introduced recently for technology that is used to support group work; the term is *Groupware*. Many writers do not distinguish between CSCW and groupware, other than to clarify that CSCW is the situation, and groupware is the supporting technology.

In SYCOMT we take a much broader view. We believe that the technology needed to support cooperative work is much more extensive than what is currently positioned by many vendors and writers in the popular and professional literature as groupware. We believe this because the range of examples we have given for cooperative work is wider than just workgroups or workflow.

We even make a different point about the term CSCW which places emphasis on computer support; we see all around us a massive convergence of different kinds of technology, not just computers. Automated teller machines (ATMs) use complex combinations of magnetic, optical, television, electromechanical, materials, communications, and computer technology. Modern supermarket checkouts use laser technology in addition.

Computers are the present point in a long sequence of work-supporting technologies. The chain includes machines, telephones, transport, printing, and so forth; we are in the middle of an evolution and line line between computers and other forms of technology is becoming increasingly blurred. Therefore we do not limit our field of study to computer supported cooperative work. We believe that a wider, more generic and useful field of study is *Technology Supported Collaborative Work* (TSCW), within which CSCW has an important role to play. Of course, from a broad historical perspective, computers, and related information technology, are the focus of the current concern for many people. SYCOMT itself is biased towards CSCW, but will explore broader TSCW issues.

At the present time, in terms of computer technology, there are substantial differences in the combinations of technology that can be used to support collaborative working. The simplest form of information technology to support a group may well be one book in which is written a note of decisions, ideas, meetings, and so forth; the most complex is almost too difficult to comprehend.

As far as computer technology is concerned, there is a world of difference between:

- simple electronic mail systems; network systems that connect a few personal computers (PCs) together; application integrating software for limited numbers of PCs and a limited range of applications, and,
- an enterprise-wide infrastructure to support collaborative working across many sites, many countries, and many organizations.

The illustration on page 5 shows a large range of technology that is used for enterprise collaborative work. Technology supported cooperative work is concerned with how to connect together small workgroups as well as very large multi-organizational, multi-national groups of people. The illustration shows that different small groups could be connected with different ranges of technologies, and these small groups can all be connected together into very substantial infrastructures. Some of the technology marketed widely today as groupware is not really "scalable" beyond relatively small configurations, and other technology not generally positioned as groupware is available and capable of supporting extremely large infrastructures.

The Project Manager for SYCOMT (Geoffrey Darnton) is proposing use of the term *Co-opWare Technology* to mean the study and application of technology in support of cooperative or collaborative working, and the term *Technology Supported Collaborative Work* (TSCW) to mean the study of the use of artifacts to support collaborative working. The word "technology" is frequently associated with the artifacts themselves, but here technology is concerned with understanding what people are doing with the artifacts.

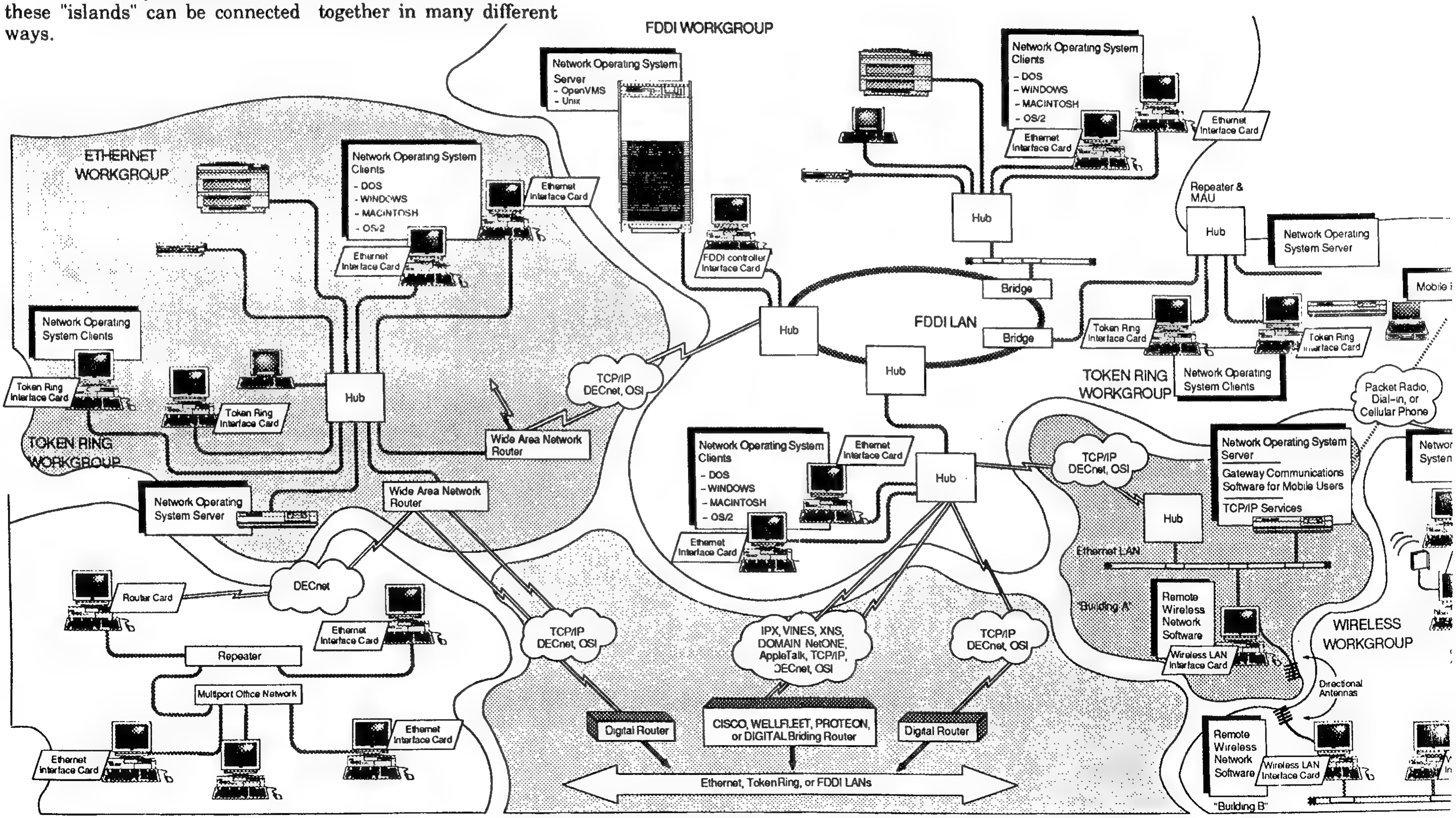
In terms of information technology, Co-opWare is essentially about communications (including telephones, faxes, etc.). It does not imply a scaling up (or down) of organizations, but is more an enabler of the "right" scale of organization.

For an organization to use TSCW does not necessarily imply that it is in the forefront of technology—in many situations the technology solutions are modest and should always be appropriate to the problem in hand. CSCW and TSCW are not primarily about finding a computer "fix". In cooperative work situations, computing and information technology need to be positioned against other sets of interests (for example business decisions; investment needs and implications) and they need to be situated with other technology.

Each island on this diagram can be a different workgroup, or collaboratory team. Very different combinations of technology can be used to support such groups.

To create enterprise-wide, or multi-enterprise infrastructures, these "islands" can be connected together in many different ways.

Technological support can be provided for the smalle workgroup, or global multi-enterprise collaboration.



Ethnography

Cooperative working usually involves a complex set of interrelationships for which an understanding can be enhanced considerably by using ethnographic techniques.

Ethnography is concerned with observing the real world of work, how it is actually done rather than how it is described in manuals, rule books or other abstractions. It tries to capture the "workaday" character of work in all its richness and variety.

How do people work in a setting to achieve an appropriate sequence of tasks and how do they work out who is responsible for what? Many aspects of work are formed into a routine, and in many situations, a great deal of local knowledge is added to more formal work descriptions.

Often there are difficulties with formal work processes. When it makes sense (and sometimes when it does not!), people find all kinds of ways to work around the rules that constrain them. Many systems are designed badly, but people may do many things to make badly designed systems work (or make well-designed systems fail!). In order to do work, it is frequently necessary to collaborate.

All this indicates the rich variety of issues around the social organization of work. These are some of the key concerns of an ethnographic study.

SYCOMT uses ethnography as one of its major approaches. Ethnography does not examine work using abstractions formed in advance but seeks to show how the work is socially organized by those who do the work. For example, although the work of a bank cashier can be described formally as a sequence of tasks, ethnography seeks to show how this sequence of tasks is accomplished within the day-to-day routines of the office, with all its interruptions, problems, varying rhythms of customer requests, and so on.

Managerial Cybernetics

Recent years have seen a fundamental evolution in thinking about organization—the "new emergent forms of organization". Traditional distinctions within and between enterprises and departments are breaking down and flatter, process oriented structures are emerging. These changes lead to a recognition that organizations are made up of autonomous units within autonomous units— like a cell in a plant, the plant itself, the business unit encompassing the plant, and finally the global corporation in its environment. In these recursive structures cohesion and autonomy are complementary rather than opposite. Cooperation is an essential ingredient, and people's disposition towards cooperative work relates to the nature of the shared tasks and the effectiveness of the shared organizational context.

Managerial cybernetics takes a broad perspective on CSCW and TSCW; it emphasizes collaborative work in an organizational context (addressing technology where necessary)–in short, it is concerned with *organizationware*.

Organizations are made of interrelated people–they allow people to undertake tasks collectively that are too great for any individual. This is achieved through people's interaction in the context of constantly changing organizational structures.

Managerial cybernetics is a tool to diagnose and achieve the goal of designing viable cooperative organized groups. This is particularly pertinent when new ways of working are being designed purposely.

The following strategies are suggested for creating effective organizations:

1. foster the creation and support of autonomous, cooperative, self-managed teams;
2. enable collaborative interaction with customers, suppliers, and other relevant participants in the organization's environment;
3. support the organizational interactions responsible for allocating resources within the organization and monitor their effective use;
4. support the interactions of people (managers and others) working at the corporate level of each of the "autonomous units" of the organization;
5. support the coordination of people activities throughout the organization.

Managerial cybernetics is concerned with the viability of different levels of autonomous organizations operating in a cohesive context. SYCOMT combines this concern for organizational viability with an understanding of the social context of work.

Why Should Business Be Interested?

SYCOMT–ethnography–managerial cybernetics–process engineering–CSCW–TSCW ... what next? Isn't this too much jargon? Why should we bother about all of this?

SYCOMT is not a pure research project—its work will be prototyped in a real-world commercial environment to ensure practical usefulness.

From the Bank's (i.e. National Westminster Bank, Plc.) perspective it is imperative that the learnings from the research and fieldwork are disseminated across the spectrum of bank work as quickly as possible. Ethnography and managerial cybernetics provide considerable data that will have been gleaned from a comparatively narrow band of banking activity (predominantly branches and local management areas).

Clearly, this information will be of most use if it can be spread across as many offices and units as possible. We have, therefore, developed a comprehensive list of thematic work chains. These look at jobs throughout the Bank identifying areas of commonality in their cooperative nature. It has been possible using these chains to draw up schedules of jobs and tasks that are functionally totally different but share the same inherent cooperative factors. Thus we will be able to prototype in one working environment and test the concept in an area that may have totally different functionality. In addition to providing potential widespread benefits to the Bank it will also provide interesting and specific data on the generic acceptability of this research for commercial organizations other than those in the financial services sector.

Thematic work chains look critically at what cooperative detail is required to complete a given task or function. This can take the form of:

- human interaction (using any available media);
- people entirely within the organization;
- customers and staff;
- third parties, customers with staff;
- any of the above supported by computer technology (on site or remote access), paper systems or a combination of both.

It is hoped that the use of these chains will help to understand the underlying structure, culture and practical difficulties in operating an organization that relies heavily on teamwork, technology, and paper. For example, the principles and stages involved in setting sales targets (a multi-disciplinary team setting a goal that is in turn given to a head office team to formulate detail before being given to the front-line to implement), are broadly similar to internal staff appraisal in that they have the same channel and structure of events (albeit totally different personnel and departments to that of the sales targetting), with supporting technology and paper support being of a similar design and availability.

As the Bank is currently undertaking a change programme designed to improve customer service we are keen to examine the ways in which we work together within the organization to deliver these services as well as how we cooperate with our customers and their representatives. This research offers the chance to take a fresh look at ourselves utilizing the most up-to-date tools and methods available.

Digital Equipment Company Ltd.

Digital is the largest supplier in the world for solutions to networked computer requirements, and is reputed to operate one of the largest (if not the largest) private enterprise networks in the world. This has created a long history of experience in CSCW on both small and large, local and distributed, scales. Part of Digital, Digital Consulting, is one of the largest consulting businesses in the world covering everything from business strategy of large companies to small configurations of PCs. Research and advanced development are conducted in many areas including new forms of organization and system development methods.

Lancaster University

Lancaster University is a leading research centre for CSCW involving an interdisciplinary grouping of computer scientists and sociologists specializing in the analysis of social cooperation in work settings. It has an established international profile in research in this area by participating in several research projects. The group has a leading edge position that stresses the role of detailed cooperative work analysis in describing and analyzing patterns of work in domains that include air traffic control, software engineering and design, and customer care in the financial sector. The group is also involved in the VirtuOsi project.

National Westminster Bank Plc.

National Westminster Bank is one of the largest financial services institutions, holding banking relationships across a very large customer base. The Bank has a substantial commitment to improved methods in the effective delivery of service to customers, and is one of the largest investors in the industry in IT and Business Process Re-design. The Bank is a substantial user of many different forms of IT; it was one of the first to develop large mainframe based automation, the first to secure its own integrated voice and data digital network for all forms of telecommunications, and has also been a significant force in the development of commercial applications

in financial services for a range of other IT opportunities in recent years.

SYNCHO Ltd.

SYNCHO is one of the foremost consulting organizations in the field of managerial cybernetics - the design and development of effective organizations through the application of fundamental principles relating to the communication and control of complex enterprises.

Since the start of commercial operations, SYNCHO has developed a strong international track record in organization consulting and change management, led by Managing Director, Raul Espejo. Its Chairman, Stafford Beer, is the founder of managerial cybernetics and the originator of the innovative and powerful organizational modelling approach, the Viable Systems Model (VSM).

SYNCHO has developed an integrated set of methods, based on the VSM, that address issues of organization identity, structure, work process management, communication flows and information management. To support its consulting work, SYNCHO is in the process of developing Viplan, an organizational modelling and training software tool incorporating a diagnostic expert system. SYNCHO's other main software tool, also currently in the process of development, is Cyberfilter, a planning and alerting tool to assist in the management of business processes.

Acknowledgments

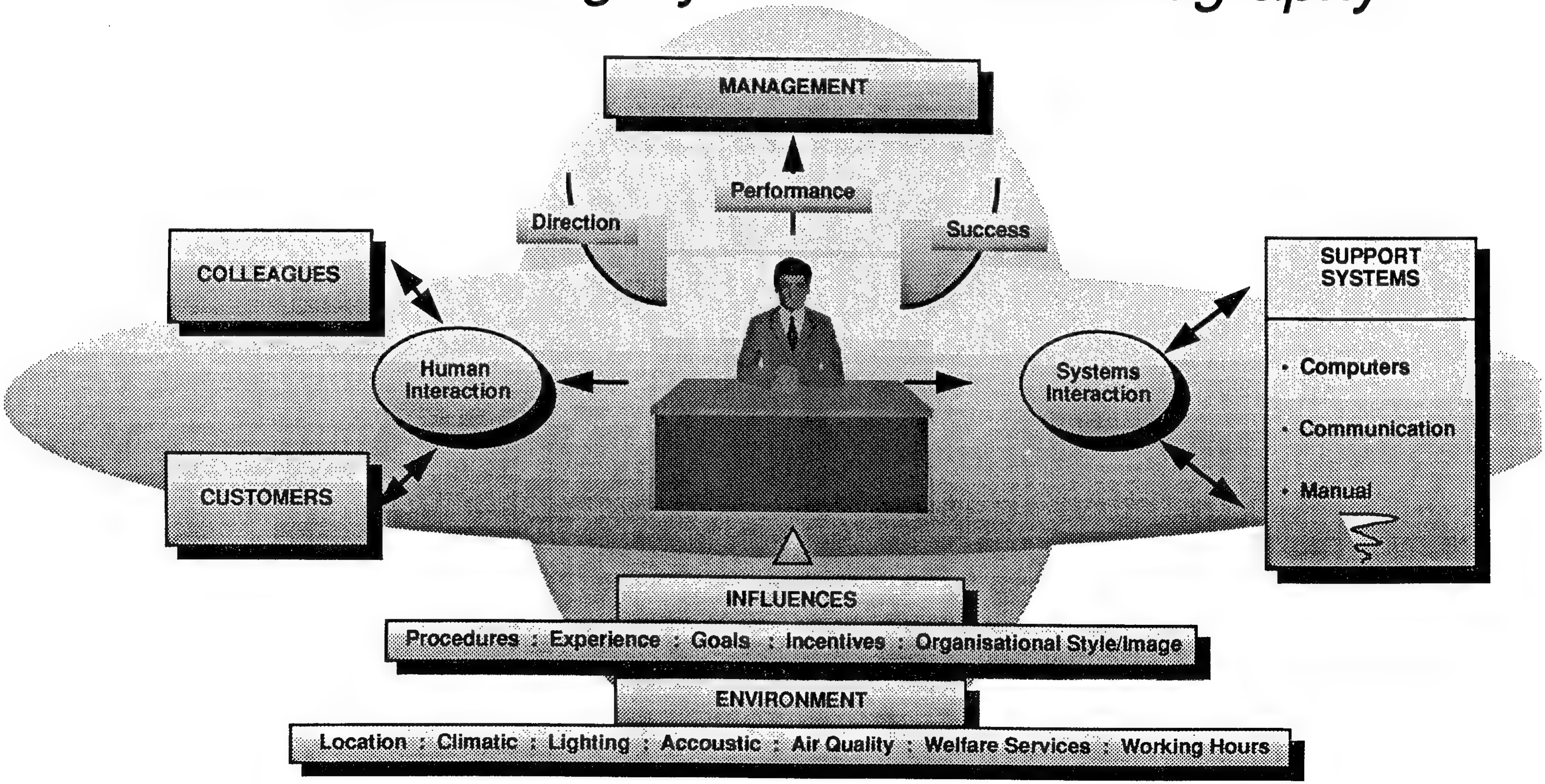
The members of the Consortium are very pleased to acknowledge the support of the UK Government's Department of Trade and Industry, and the Science and Engineering Research Council (SERC), whose assistance towards the work has provided an essential catalyst in bringing the partners together in an exciting Project that otherwise would not have taken place. SYCOMT is part of the DTI/SERC CSCW Programme.

This document is a small distillation from a great deal of material. It represents the work of many people. For *Tomorrow's Organization*, John Williams prepared a presentation of SYCOMT and some of his material for that has been incorporated here. The co-ordination of the whole effort to make this document available was ably managed by Moksha Darnton. The large CSCW technology diagram is but a small part of the substantial technical material used and was compiled by Susan East with some very insightful guidance by Nick Johnson. Antonia Gill made very appropriate editorial suggestions and this improved the original draft considerably.

SYCOMT

Organisations & CSCW

Combining Cybernetics & Ethnography



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National Westminster Bank PLC

Appendix D
CD - Collaborative Documents

TOMORROW'S ORGANISATION

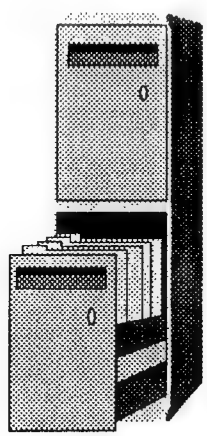
5. CAPTURING DOCUMENT RELATED ACTIONS

THE COLLABORATIVE DOCUMENTS CONSORTIUM

Jon Pyke

Tomorrow's Organisation

Collaborative Documents



Agenda

- The Consortium
- Background
- The Technology
- The Solution
- Summary
- Questions

The Consortium

- Staffware Plc - ***Workflow*** Experts
- Brunel - ***Document*** Experts
- Imperial College
- The Users...
  - BP
  - Pfizers
  - Grand Met

Background

- Tomorrow's Organisation
- 25 years in the making
  - 1969 Tomorrow's World BBC
  - Office of the Future
  - No Paper !!!!!!
- About Time too...

Background

Source OECD

During the 1980's, Manufacturing productivity increased by over 75%

In the same period, Office productivity increased by a staggering....

3%

Background

- The 1980's
  - Decade of *Individual* Expansion
  - Decade of *Company* Expansion

Background

- The 1990's
  - Focus on the Organisation
    - More efficient
    - Higher quality
    - Downsizing
    - Asynchronous working

Background

- The Needs of the *Individual*
  - Control over own actions
  - "Martini" access to others
  - Not subordinate to others schedules
  - Minimal administration

Background

- The Needs of the *Organisation*
  - Business Process followed
  - Quality ensured and maintained
  - Degree of coordination
  - Efficiency of the whole

Technology - *Staffware*

- Workflow Automation
  - Ensures that the B.P. is followed
  - Ensures standards maintained
  - Coordinates tasks
  - Reduces Admin. for individuals
  - Provide responsive environment
  - Maximises use of resources

TRANSFER

Tech Transf in
Resh - lessons
[illegible] across the
[illegible]

Technology - Brunel

- **Empower**
  - Powerful Document Management
  - ESPRIT funded
  - Fully Image capable
  - Robust low cost "out of the box"
  - High Volume Client/Server option

Technology - *Consortium*

- Workflow into collaboration
  - Weaken the flow - Cleave process
  - Enhance communication to ensure
    - each talks same language
    - each conveys self unambiguously
    - remove time and place constraints
- Provide true CSCW for business

The Solution

- Project delivers 3 new functions
  - Reflexive Documents
  - Powerful document versioning
  - Powerful replication

The Solution

- Reflexive Documents
  - Documents speak for themselves
  - Tell the reader about change
  - Information about information
  - Changes alter the process flow
    - Still maintaining the formal B.P.
    - Still maintaining audit details
    - *Ad-Hoc* elements where needed

The Solution

- Powerful document versioning
  - Maintaining integrity during use
  - many can edit, 1 version maintained
  - All changes in most recent version
  - Removes dependency on others
  - Time and place independence

The Solution

- Powerful replication
  - Everyone sees same information
  - Changes reflected in all sites
  - No-One out of step with the others
  - Quality, consistency ensured

Summary

- Real Product
- Meet needs of...
  - Individuals
  - Organisation
- Enable you to be part of the process regardless of time/space
- Improve Office productivity

Appendix E
CORECT - Collaborative Requirements Capture

TOMORROW'S ORGANISATION

4. COLLABORATIVE REQUIREMENTS CAPTURE TOOL

THE CORECT CONSORTIUM

Tony Mant

PROJECT PRESENTATION

FOR

THE CORECT ✓ PROJECT

PRESENTED BY

TONY MANT
SENIOR EXPORT MARKETING MANAGER

RACAL INSTRUMENTS LTD

ABSTRACT

The definition of systems requirements is demanding, needs skilled personnel, requires collaboration between people with different kinds of expertise, yet is slow and prone to expensive oversights.

The project, being carried out jointly with Racal Research Ltd, Racal Instruments Ltd, the Universities of Edinburgh and Sussex and Intelligent Applications Ltd, seeks to support requirements capture with a database of information for systems specification.

Controlled acquisition of information will improve competetiveness and accuracy.

The tool will also give designers rapid feedback and make requirements immediately visible to all who need them.

1. CORECT Aims

The CORECT project seeks to support systems requirements capture with a database of information for the specification of systems. The controlled selection and combination of the information modules in the database to meet customers' requirements, will improve the speed and accuracy of the definition of the requirement and improve a company's competitiveness.

It will make the acquisition of systems business more efficient in terms of selecting which opportunities are to be pursued, reducing the effort that is expended in capturing the business and improving the accuracy of defining exactly what the customer wants and expects.

2. Systems Business

The definition of systems requirements is demanding, needs skilled personnel, requires collaboration between people with different kinds of expertise, yet is slow and prone to expensive oversights.

Systems are defined here as the combining of a number of pieces of catalogue equipment, probably controlling them from a central point, and collecting and processing the results of whatever is the task to be performed.

For an automatic test system, this would be a combination of instruments providing stimuli for a Unit Under Test (UUT), instruments to evaluate the response to the stimulation, a switching system to direct the stimulus and power to the correct connections on the UUT and to feed the response back to the correct measuring instrument. This would also include a computer controller and test programs to run a series of tests on the UUT.

For a communications system this would be a combination of receivers, transmitters, aerials, signal distribution, processing and recording.

A company usually decides to move into systems business as a natural progression, when it is realised that it is supplying a large number of pieces of equipment to a customer who is combining them into a system, and believes that it could itself benefit from the value added to its equipment by the systems company.

3. Putting a System Together

Ground rules for this process are normally established before setting out to acquire systems business. The company normally considers what gaps there are in its own products in the business area in which it is intending to participate, and makes arrangements with other divisions of the company, and other, possibly competitive, companies who can provide products complementary to its own.

- When a new potential business opportunity is detected, it is first confirmed that it is in the business area of interest.
- Initially it will be checked whether the systems can be completed with products from the company which is intending to supply it.
- If not, it will then be determined whether other divisions of the company have products which can complete the system.
- If the system is still not complete, then products from other companies may be used to fill the gaps.
- If gaps remain, it will be considered whether an item should be developed specifically for the project under consideration, taking into account other business prospects that could use something similar, and whether the newly developed product is likely to be usable in future projects.

  Any newly developed item contains non-recurring costs that could put the overall system price outside the customer's budget. If the item is likely to be able to be used in future systems, a commercial decision may be made to assign only a portion of the development costs to the first system to use it.
- If it is not cost effective to develop a new product, then a counter proposal may be made to the customer which achieves, say, 95% of what is desired but at a significantly lower price and risk than would be demanded by satisfying the requirement completely.

At each stage, a financial analysis should be made, looking at the overall profit margin that can be achieved and what contribution each category in the system makes. That is, own division equipment, other division equipment, other company equipment, etc.

A library or database of building blocks is established, which contains the preferred components for a wide range of system variants. This will be initially in the form of a collection of data sheets and equipment catalogues and the cost of them to the company. The database will be expanded as systems activity increases and experience is gained.

4. Acquisition of Systems Business

Acquisition of systems business is a long and iterative process. The salesman should get involved with a customer requirement as early as possible and help him define just what the requirement is.

The process may go around the definition loop a number of times over a number of years with increasing involvement of more and more company personnel. The knowledge of the requirement and the possible solutions to it build up and a re-assessment of whether the company should bid may be made at several critical times. A formal proposal may be very expensive to produce and draw on scarce resources. It is vital to be as selective as possible about which requirements to bid for.

Capturing overseas business can be expensive and time consuming, and for systems business may take several years to acquire. Most companies use local agents who usually represent other companies as well. It is always cost effective to get the local agent to do as much of the early definition of requirements as possible.

There is an ever present dilemma for Sales Managers whether to make their sales force territorial specialists or product specialists. There are advantages and disadvantages with each option and many variants or combinations of the two.

In the Defence field, operational specialists are often employed in sales and marketing departments. There is much to be said for this as the decision makers may be primarily operational rather than technical specialists. There is often a limit to the depth of the technical knowledge of the operational specialists and they may need to take an engineer with them to cover the technical aspects.

A portable Personal Computer based tool, which provides overseas agents and territorial and operational specialists with deeper technical knowledge and system and price building capability, is a potential sales force and other resource multiplier. It will allow limited travel budgets to be allocated in the most productive manner, greater efficiency in the definition of complex systems, better assessment of which opportunities to respond to and more efficient preparation of technical and commercial proposals and negotiation of contracts.

5. Consortium Members

The CORECT consortium consists of two companies within the Racal Electronics group, Intelligent Applications Ltd and the Universities of Edinburgh and Sussex.

Figure 1 illustrates the architecture of CORECT and the distribution of the tasks within the consortium.

Racal Instruments Ltd

Racal Instruments was formed in the 1950s to produce electronic test and measurement equipment and became Racal Dana with the acquisition of Dana Laboratories in 1977. In 1989 it absorbed Racal Automation which had been formed in 1977 to produce Automatic Test Equipment Systems (ATEs) to support military electronic equipment and systems.

The company now has two marketing areas, Defence and Commercial, which promote both measuring equipment and systems produced by common design and manufacturing departments. Increasing systems business will be a significant factor in the company's future growth.

RIL will be the "user" in the consortium and will be responsible for the information database, the interface between the database and the presentation of information to the user, and user trials.

Racal Research

The Racal Electronics group has a central research organisation, Racal Research limited (RRL), which develops new technological approaches to the point where they can be applied to products and systems.

RRL will be concerned with project management, the distribution of tasks between collaborators and the transfer of technology within Racal. RRL has considerable experience in the management of advanced IT projects as prime contractor in the IED POETIC and IDAS projects and previously in an Alvey Large Demonstrator.

Intelligent Applications

Intelligent Applications are designers and manufacturers of Artificial Intelligence Applications for industry. Their products include software tools for fault finding on electronic printed circuit boards, monitoring of gas turbines, energy management, machine tool fault diagnosis and case based reasoning tools.

Their role in this project is to define the database format and design and implement rules for checking coherency and completeness to ensure that the user is putting together a sensible and complete system.

iiversity of Edinburgh

niversity of Edinburgh are specialists in Natural Language Generation.

'hey will ensure that the database information is stored in such a way that it can be automatically retrieved and presented to users in a format that is appropriate to their needs.

University of Sussex

University of Sussex specialise in CSCW, multimedia interfaces, workplace studies and user interfaces.

Their roles in the CORECT project are to study and analyse how Racal Instruments, th user, currently operates, to design and implement the user interface and to conduct studies and analysis of user reaction to the CORECT tools at various stages of their development.

6. Other Considerations

The CORECT project aims to produce a tool to improve the efficiency and accuracy of capturing systems business.

It follows on from a previous DTI funded project, Intelligent Document Advisory System (IDAS) which was aimed at making the documentation of systems simpler, less expensive and on-line. This was by providing the design engineer with tools such that designs from the earliest stages could be used to produce and capture the final system documentation.

In fact, the earliest stages of system design are the discussions between the customer and the salesman.

There has long been a good case for the "rapid prototyping" of system proposals. That is, there comes a point, particularly for some overseas territories, where it is better to submit an outline proposal and order of magnitude price, than to continue to question the customer about his requirements.

The initial outline system block diagram and budgetary price are expanded, often with several iterations, into a formal proposal. The initial discussions therefore, should take into account how a proposal will be prepared and how such a system will be designed and manufactured.

The rules used should allow an analysis of profit margin and an assessment of the probability of winning the business to be made at various stages, so that a considered decision on whether to continue with the opportunity can be made. Proposal costing should be put together in such a way that profit margins in areas of interest can easily be examined.

Order Forecasting

The assessment of the probability of capturing an order is often used as a weighting factor to forecast the average value of orders that will be achieved over various periods of time. The factors which have to be considered are the same as those influencing the Bid/No Bid decision.

The management of the company depends upon this forecast which, to give a company the best chance of success, should be as accurate as possible.

Most forecasting ultimately depends upon the judgement of the person making the forecast. Even when a number of people all work to the same model, such as in a Sales and Marketing department, varying results are produced according to the degree of optimism, realism or pessimism in the forecaster's character. It is highly desirable to make order forecasting as objective as possible.

An automatic system of order forecasting could keep track of probabilities assessed by individuals and compare it with the actual order capture. This comparison could be used to calibrate individuals' assessment of probability and/or the model used, and correct for it.

Resource Forecasting

If quotations and proposals are prepared in resource categories that are of interest to a company, such as Manufacturing, Hardware Engineering, Software Engineering, Test, etc., then this information can be used, together with the promised delivery, to assess what resources are needed and when.

Conversely, when preparing quotations and proposals, available resources should be reviewed, in conjunction with other current quotations and proposals, to assess what delivery can be achieved.

The method of weighting the total order with its probability of capture provides a reasonably accurate average for a large number of relatively small value prospects. For fewer, larger value opportunities, peaks and troughs are much more evident. In reality, the value of the order that is booked is usually either 100% or zero. Automation of resource planning, using available Order Forecast information, allows "what if" scenarios to be examined to make a best estimate of resources needed or the delivery that is attainable.

Works Orders

When orders and contracts are received by a company, they have to be distributed as work packages, together with the cash available to perform the work, to the departments that have to do it. Again proposals should be put together with cognisance of this so that orders can be efficiently digested by a company.

Computer Supported Co-operative Work

The above activities all involve a number of departments within a company using different aspects of available information to achieve a common aim. If this information is stored electronically and made available in a controlled manner, when each user needs it, in the format that is most useful to him, then this must improve the efficiency of the activities.

Case studies will be used to influence the design of CORECT so that it reflects actual, rather than assumed working practices. The case studies will use observational fieldwork to identify the relationships between the technological, organisational and social dimensions of the working environments in which the system will be used. This should clarify some of the processes involved in requirements capture and the means by which people from different departments communicate and coordinate their ideas.

Figure 2 illustrates a vision of CSCW within a company, centred upon CORECT.

- A system is put together from modules in the CORECT database by a systems salesman.

- The technical details of the own-division building blocks are maintained by appropriate engineering specialists.

- Technical details for products from other divisions and companies are maintained by the marketing systems specialist, in liaison with engineers from other divisions and companies.

- Each building block has a price associated with it which is linked to its origin.

    Standard catalogue equipment prices are linked to current price lists maintained by the commercial departments of the company divisions.

    Project specific equipment prices are linked to estimates made by the estimating department at rates controlled by the financial department.

    Other company products are linked to quotations maintained by the purchasing department.

- CORECT makes different views of the system build up available, facilitating financial analyses at early stages, to assist in the bid/no bid decision and to compare available resources with the demands of the system and allow the delivery time to be assessed.

- The code indicating the position of the order prospect in the market place is assigned by the responsible salesman.

- The Sales Manager uses these codes to assess the probability of capture to assist in the bid/no bid decision and as a weighting factor to forecast the value of future business.

- The weighted totals in the categories of interest are made accessible in a controlled manner to the various departments of the company, such as design engineering, production engineering, training, documentation, to enable them to assess resource requirements.

- A view of the system build up will be tailored to the needs of the company to allow contracts for systems to be divided out financially and technically between the departments that will have to perform the work on the contract.

Cognisance of all these aspects will be maintained during the project to ensure that the CORECT tool can be utilised as widely as possible.

7. CORECT Milestones

There are three significant milestones:

the production of a prototype by the end of 1994,
an intermediate system in early 1996,
the final system and report at the end of 1996.

The results of the evaluation and user trials of the prototype and intermediate systems will be used to refine the following systems. This rapid prototyping and user evaluation, coupled with continuing workplace studies, will ensure that the system design will match the user needs.

8. CORECT Project Status

In the past, Automatic test systems were produced by taking remotely controllable bench top or rack-mountable measuring instruments and controlling them by a suitable computer. In recent years, a system called VXIBus has evolved to produce measuring instrument modules that are specifically designed as building blocks for Automatic Test Systems. These VXI modules do not contain individual power supplies or have front panel controls and indications and in consequence are smaller, lighter and less expensive than their predecessors. All future automatic test systems will be formed from modules like these.

Racal Instruments were a founder member of the international VXI consortium and have a catalogue of VXI products which will form the initial database for the CORECT project.

Within the project, workplace studies of how potential systems business is handled by Racal Instruments has started and continues.

A method of assessing the probability of capture of orders, devised by a Senior Racal Instruments Marketing Manager to remove the subjectivity of the assessment, has been implemented as a software tool. This will be used to monitor the assessed probability of a number of business prospects over the next year and then to analyse the assessments against the outcome of the prospects.

A cumulative costing tool has been implemented and will be used to assess the usefulness of such a tool with other systems companies within the Racal Electronics Group.

9. Summary

A project plan, detailing what each member of the consortium will do has been produced and agreed.

Workplace studies to define the aims of CORECT are in progress.

Tools to assist in the definition of the project have been produced. They are being used to collect data and carry out market research.

The conditions are right within Racal Instruments and the IT world for such a tool as CORECT with the widespread use of networked desktop Personal and Notebook Computers. It has become cost effective to do this in only the last couple of years.

The CORECT tool is initially aimed at the capture of contracts for Automatic Test Systems, but the principles are the same for all modular systems that have to be configured to meet particular requirements. Other applications have already been identified both within and outside the Racal group

The time is correct for CORECT.

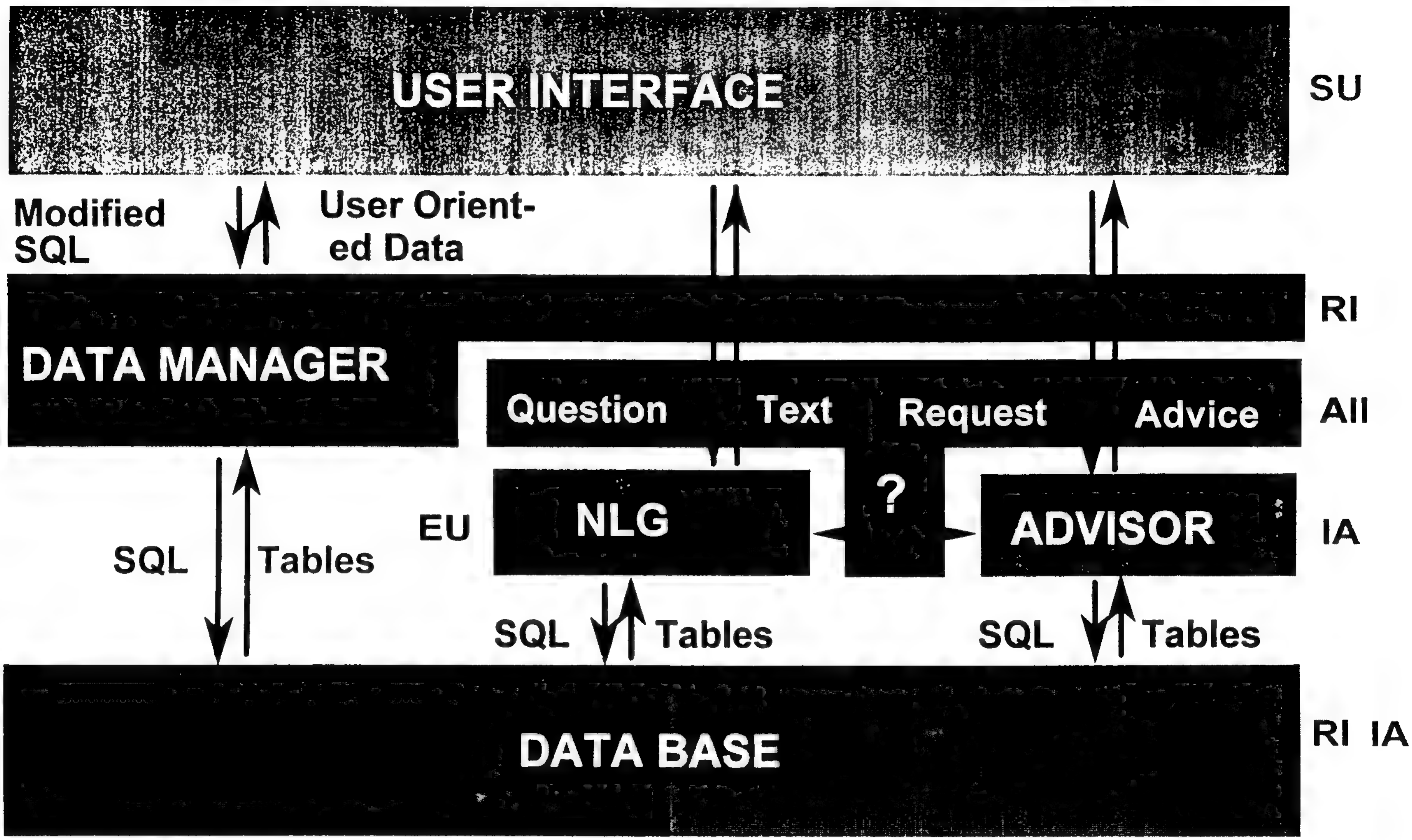


FIGURE 1, CORECT ARCHITECTURE

COLLABORATIVE REQUIREMENTS CAPTURE TOOL, CORECT✓

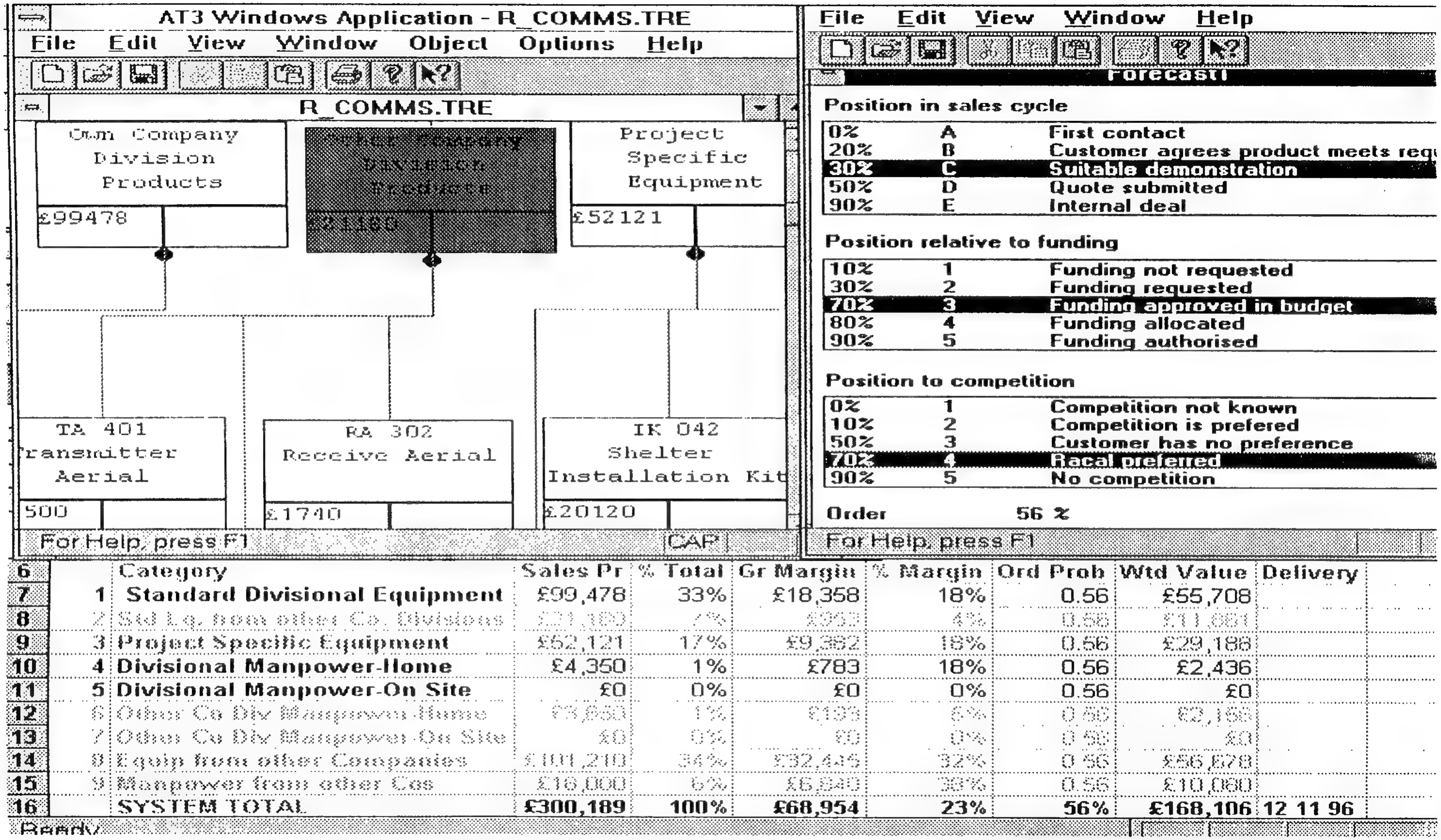


FIGURE 2, USE OF CORECT

Appendix F
DUCK - Designers' Use of Co-operative Knowledge

7. DESIGNERS' USE OF CO-OPERATIVE KNOWLEDGE

THE DUCK CONSORTIUM

Lil Bianchi

Tomorrow's Engineer

Phil Turner[1], Peter Mason[2], David Jenkins[3] and Lil Bianchi[4]

1. Current Practice, Problems & Opportunities

1.1. Overview

The need to maintain a competitive edge in high technology systems, where a specialist mechanical structure is augmented by advanced electronics, electrical and mechanical subsystems, is uppermost in the minds of senior managers. These markets which encompass such things as warships, aircraft, and oil-platforms are highly competitive, very complex and increasingly demand the application of concurrent engineering techniques, often as the extension of conventional computer assisted engineering.

This perspective is best illustrated by a very recent and successful example in the development of the Boeing 777 airliner[5]. Boeing had found themselves third in the market behind McDonnnell Douglas and Airbus in delivering a widebodied aircraft which was smaller than a 747. As their director engineering put it, 'To catch up we had to build something better' and to do so they embraced what they described as *simultaneous engineering*. This consisted of replacing the usual lifecycle of specification, design, build, testing and so forth performed sequentially with some of the down-streaming tasks being performed upstream. In

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[1]MARI Computer Systems Ltd

[2]BAeSEMA Ltd

[3]University of Paisley

[4]MARI Computer Systems Ltd

[5]*Boeing Boeing*, Business Life Magazine, December/ January 1993/94

addition to this Boeing invited a number of technically strong customers, including British Airways, to participate in the whole process. The input from their customers proved to be both unexpected (for example, the introduction of flexible zone for the toilets and galleys) and rewarding - British Airways placed orders for 15 aircraft with an option on another 15. Furthermore this partnership is set to continue.

While this is a good example of the effectiveness of concurrent engineering, the process may be extended to the early conceptual and architectural stages of the engineering design process, where 80% or more of the final cost is determined, yet a mere 20% or less of the project effort is expended[6]. Although computer-based tools already exist to support the engineering designer, few provide assistance in these early crucial stages of design where the only records kept are on paper, if at all. Enter the DUCK project, more of which later.

Both concurrent engineering and CSCW more generally carry with them a significant dependency, namely, the need for an appropriate communications infrastructure.

1.2. Current Communication Practice

Many large companies have sites which are widely distributed: this distribution is often partly due to historical reasons, the need to be in proximity to prime customer sites and so forth. As a consequence divisions, project teams and specialisms are often distributed across geographically distant sites. This typically has several consequences:

1. Co-ordination is achieved through frequent meetings. This means that travel is a heavy overhead: senior staff will be away from their base at least one day a week and frequently as many as four or five days. Few regard such travel as a perk. The frequency of meetings means that geographically isolated staff do not feel cut off, but obviously they do miss out on potentially important informal contacts.

2. Where it is considered that a team or part of a team need to be co-located, team members are moved to the common site, requiring them in many cases to move house or commute long distances daily or weekly. The team is then redistributed at the end of the project. This process is naturally highly disruptive.

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[6]Dixon, J.R. and Duffey, M.R. (1990). The neglect of engineering design. *California Management Review*, 32.

3. Companies often nominate technical authorities in specific subjects who act as advisors. They are rarely dedicated to any one project for any length of time and are unlikely to become permanently based at sites outside their home base because they are required on a contingency basis, there being insufficient work to occupy an expert full-time. Furthermore it would be unlikely for one expert to be able to cover all specialist requirements so a panel contributing on an *ad hoc* basis often pertains. Current practice is to have the remote experts travel as required, but this makes them unavailable to other sites and removes them from files and reference material.

1.3. The Real Cost of Computers

In the case of engineering design, the introduction of CAD (Computer Aided Design) has not come free of cost to the designer. It is for no little reason that CAD is sometimes referred to as Computer *Aggravated* Design. Poorly thought out systems have negative consequences both at the level of the individual and the wider working group. Whitefield[7] has drawn attention to the demands of sophisticated CAD systems on the information processing capacity of the designer, thus removing resources from the design work itself. At the level of the workgroup, coordination becomes a major headache and even a source of friction between team members as Rogers[8], for example, illustrates. In effect, with systems such as that described by Rogers, individuals are required to put in extra coordination effort in order to use the new collaborative systems effectively. The problem is that in the change from paper to electronic drawings, the transfer of ownership and the ability to edit the drawing is no longer overtly and physically mediated by the handing over of a paper drawing sheet. Access to the electronic drawing must be neither too loosely controlled (so that more than one person is editing the drawing at once) or too restrictive (so that only one person can even consult the drawing for reference). In brief, the pattern and means of access control must reflect the working patterns of the group.

1.4. Competitive Pressures

All sectors of industry are facing a very competitive environment with enormous pressure to keep costs down and provide adequate return on

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[7]Andy Whitefield, *An Analysis and comparison of knowledge use in designing with and without CAD*, Knowledge Engineering and Computer Modelling in CAD - Proceeding of CAD86. London. Butterworths.

[8]Rogers, Y. (1993). Coordinating Computer Mediated Work. CSCW, 1.

investment. In a people dominated environment, such as design, this pressure translates into a need to keep all of the staff productively employed at all times. There is no 'manufacturing for stock' or any underpinning product revenue stream.

Overtime provides some flexibility but where there are a number of small projects to be fitted into the available hours, the ability to transfer work from one person to another (or team to team) and yet maintain adequate supervision is paramount. Managing the changeover between the different lifecycle phases is a particular problem.

Paradoxically, competition frequently promotes inter-organisation collaboration as it is often more cost effective to purchase some aspects of the design rather than maintain a team capable of absorbing the peak load. Many multi-national projects need collaboration as a requirement for participation whether or not it is strictly necessary for technical reasons. In both these cases, control of the design constraints and verification of the proposed solutions are necessary to ensure the integrity of the final product.

1.5. The Empowered Individual

In the last 40 years the computer industry has made many promises of how organisations can benefit from the introduction of IT and its associated infrastructure. We are now in a time when personal computing has empowered the individual in a significant way. Computer applications of considerable power can be purchased off-the-shelf and at costs which are within the budget of departments, projects, and frequently individuals. As a result many computer applications are now purchased and configured locally by virtue of decisions taken by the future end-users themselves. In many organisations end-user departments have grasped this opportunity not only because the cost is relatively low, but also because it enables them to develop systems to suit themselves rather than having to rely upon central systems defined by technologists responsible to the headquarters of the organisation. The kind of empowerment varies with the type of work a person is performing. A secretary may be able to produce documents of published quality, a designer may be able to develop and test many different designs before physical prototypes are necessary, an author may be able to write and type a complete book, a manager may be able to assess information about the operations of the business and try many 'what happens if?' scenarios for the future, and an accountant may be able to try many different spreadsheets of the finances of complex projects. The opportunities are immense. For most knowledge workers a personal computer is now the virtually indispensable work tool of their profession.

The personal computer started life as a machine for an individual but now by virtue of networking it is the access point to a wide variety of other facilities and is a means by which an individual can communicate with many colleagues around the world. As a result, many large scale systems are now based upon autonomous and semi-autonomous local area networks providing PC based applications to the desktop. This change in the pattern of developing systems inside the organisation has had profound implications. It is an end-user revolution because it gives a great deal more opportunity for end users to develop systems to meet their needs. But, by the same token, it can make it more difficult for senior management to co-ordinated and control business processes. The personal computer together with inexpensive, reliable networking have brought a technology that is spreading quickly through many organisations from the bottom up. While it has proved useful to the individual end user the downside is that it can cause major problems for senior management and their senior technical specialists because it can bring chaos to an IT strategy and any attempt to create integrated technical systems for co-ordination and control. So the structure of this dialectic is now clear: personal empowerment versus computer and management chaos.

1.6. In Conclusion

As we have seen neither current communication practice nor current technology nor the uncoordinated use of that technology by empowered individuals will fully support CSCW. Providing users with the latest release of the fashionable groupware product, without change in the organisational makeup of their work will not provide the expected benefits or solve their problem in an instant. And those problems which have been identified in DUCK are: the cost and inconvenience of travel; the disruption caused by co-locating project teams; the associated difficulty of co-ordinating the work of a distributed team and lack of recorded rationale for design decisions in collaborative work

2. DUCK: Designers Using Cooperative Knowledge

2.1. Who and What we are

The consortium comprises MARI Computer Systems (lead partner), BA^{e}SEMA and the University of Paisley. The University of Paisley have considerable experience in the area of computer support for engineering design, while MARI Computer Systems will be contributing expertise in software design and build, CSCW and user interface design. BA^{e}SEMA

are active in large scale distributed engineering design and provide the end-user and industrial context for the project.

DUCK will provide a specialist toolset for Computer Supported Cooperative Work in the practice and management of engineering design. The toolset will be designed to be used in conjunction with existing groupware technology where this is appropriate. It will be designed so as to avoid any prescriptive constraints on the design style of the individual user, and to be capable of reflecting organisational practice in any particular context.

2.2. Striking the Balance: Infrastructure & Organisational Culture

Computer applications introduced in isolation will probably fail. IT has promised much but there is growing evidence of concern: questions about value for money, the 'uptake' problem, publicity for expensive disasters, for example the London Ambulance system. Survey evidence indicates that there is an alarmingly high failure rate. General surveys suggest 20% success, 20% complete failure, the remainder are at best partial or qualified successes. Therefore potential users need to be convinced, consulted and enthused .

DUCK's principal aims are therefore:

- To derive a well-founded set of functional and non-functional user requirements for tools to support cooperative working in engineering design at the level of the users, group and organisation.

- To iteratively develop a toolset for distributed design teams which will not prescribe particular working methods. In fact, DUCK will only work if it integrates seamlessly with existing tools and techniques. To this end the appropriate off-the-shelf technology will be used.

- To evaluate the effectiveness of both off-the-shelf technology and the specialist toolset in real pilot sites; employing an iterative and incremental implementation, and evaluation approach. Specifically this will involved the early introduction of technology and applications (within the first 12 months) which will serve to generate further user requirements; and facilitate the necessary accommodation required of working practices.

2.3. The DUCK Technology

DUCK will comprise off-the-shelf groupware products software to support application sharing; an appropriate communications infrastructure; and the Design History Editor (DHE) which is an innovative component used in an innovative setting.

2.3.1. The Design History Editor

The original concept of the Design History Editor emerged from work in the Engineering Design Research Centre in Glasgow where it was recognised that design is iterative and that a good design history mechanism was essential to achieve improvement in the design process. Further, the great majority of designers use annotated sketching[9] in the early stages and are almost invariably required to work in a personal logbook. For a particular product, the set of logbooks used contain the history of the design. These are used for design audits and as the basis for future modifications of the design. The information contained in them is also of use to other human designers, to a degree. However, even notebooks such as these do not contain the complete history since amendments invoving erasure and redrawing will be lost. Linking such information to the product model would provide a much more complete record of the design, complementing the forward look into the manufacturing processes needed to build, make, etc. the product, with the backwards references to the design process from which the product emerged. Obviously these problems and opportunities are magnified when this design work is being conducted co-operatively and when the designers are physically distributed.

Asking the designer on-line for an explanation of decisions taken is intrusive, deflects the designer from the course of design, and, most significantly, results in a partial or even incorrect explanation. This is not deliberate, but occurs because of the fact that design is based on procedural knowledge, which is not available to articulation (e.g. try explaining to someone how one rides a bike). Although professionalism demands reflective action, this is not in the forefront of the designer's mind as design progresses. Design is, after all, done by the practitioner, rather than reflected on. This luxury is, perhaps, only permitted to design academics, to design researchers.

Therefore a design history capture tool based upon explicit explanation and comment from the designer simply will not work. From empirical

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[9]For example, *Engineering Design Methods*, Nigel Cross, OU, 1989.

research it became clear that in this situation the designer would do what he or she wished to do outside the support offered, and then tidy up the process to fit the method offered as the tool was used. In this way, the individual and particular elements and aspects of that design process by that designer would be severely filtered and much that is crucial to both an understanding of that design's history, and to an understanding of design per se is inevitably lost. The solution to these dilemmas is to abandon the idea that one should seek to understand what the designer is doing and concentrate on making what he or she has done accessible for use in the future, that is, to construct a history of the design process linked to the final form of the designed product.

Not only is this an issue at the early stages of design but at the completion of the preliminary and detailed design stages of a major project, the relevant engineering information is usually held as CAD files. However when the design goes into fabrication, it is often necessary to make a variety of minor on-site structural modifications to the original design, which may go unrecorded on the main design computer[10]. Furthermore unrecorded changes may also take place during installation and throughout the active life of the ship, oil platform and so forth whenever maintenance or retrofitting programmes are carried out. As a consequence the CAD files held by the designers may not always correspond to the structure itself. Clearly this situation is not desirable for a number of reasons.

To address the need to avoid biasing or skewing the design process, and the resulting design, a metaphor is employed, that of the design journal itself. If the designer is provided with technology which can be interacted with as if it were the physical paper based design journal, ie an A4 hard-backed notebook, then the bias is minimised. Further, immediate benefits can be offered to the designer to motivate the use of the technology. For example, constraints can be maintained between statements, assertions, etc. made on various pages which would normally be out of view and would require recall on the part of the designer for them to be recalculated or used to check new parameter values, or whatever.

The way in which a team should work has been described as: we can think of a set of workers all looking at the same blackboard, each being able to read everything upon it and to write upon it when it is judged that something worthwhile can be added to it. This blackboard behaviour arises from the designers' understanding of the state of the problem together with their response to it. That is, in a cooperative session, each designer observes the solution space and intervenes actually as in the

[10]New Wave CAD - data for life, *The Journal of Offshore Technology*, February, 1994.

metaphor. In fact, in DUCK the metaphor is instantiated upon a computer mediated distributed whiteboard.

2.4. The Pilot Application areas

Potential application areas which have been identified include:

- Mechanical engineering. Support for the early stages of design before the use of team-based CAD tools, and communication support for distributed groups.
- Software engineering. Support for the early stages of design before the use of team-based CASE tools, and communication support for distributed groups.
- Management meetings. The problems associated with which could be ameliorated by means of desktop conferencing (with or without video[11]), shared access to the MIS.
- Multi-site proposal (tender) preparation. Again improved multi-site, multi-media communications could improve current practice, together with shared editors, and annotational facilities.

(NB, the unexpected similarities between software and mechanical engineering have not gone unnoticed.)

3. The Benefits

The benefits of introducing CSCW into engineering design and the DUCK technology in particular will be the mitigation of:

- cost and inconvenience of travel
- disruption caused by co-locating project teams
- the difficulty of co-ordinating the work of a distributed team
- lack of recorded rationale for design decisions in collaborative work.

Equally importantly, there should be a resulting increase in efficiency and improvement in the quality of work. More specifically, the software to be developed within DUCK is expected to support the special requirements of collaborative design and the capture of design rationale, and the

[11]Some managers insist that they need to see the whites of their colleagues' eyes.

pragmatic requirements of integration with mainstream off-the-shelf groupware tools.

The overall long term benefits to the UK engineering community are expected to be a shortening of design-to-production timescales through the increased effectiveness of cooperative working and an improved quality and reliability of design through design reuse. As the DUCK system will be non-prescriptive and context neutral then any domain of design can be supported in this way.

Appendix G
ICW - Integrated Co-operative Workspace

CSCW

ARCHITECTURE

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ICW Integrated Cooperative Workspace

ICW PROJECT

ICL Openframework	ORACLE
NEXOR	MICRONICS
FRETWELL-DOWNING	HALLAM
ARIES at CITY Demonstrator	SHIP Demonstrator

Position Techniques

Sheffield Hallam

ICW Integrated Cooperative Workspace

CSCW ARCHITECTURE

* The Need
* The Response

Look at Cooperative Work thro' Computers

ICW Integrated Cooperative Workspace

CSCW SCOPE

Between

* Individuals
* Workgroups
* Divisions
* Organisations

ICW Integrated Cooperative Workspace

Working [illegible]

[illegible] building a city

CSCW REDEFINED

Corporate

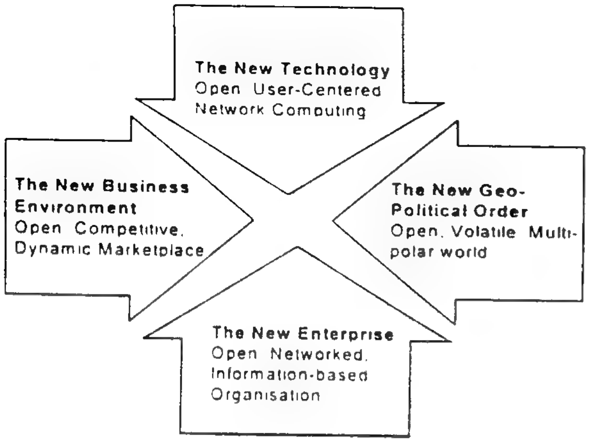
Standards

for

Cyberspace

Working

ICW Integrated Cooperative Workspace



Paradigm Shift
The New Promise of Information Technology
Tapscott & Caston

CW Integrated Cooperative Workspace

There is no reason to believe that there will be a reduction in the rate of change of various technologies, economic systems, new business methods, growth of new competitors, and so on

If anything, **the rate of change** of many of these factors is **likely to increase.**

Management in the 90s Report
Massachusetts Institute of Technology
for ICL

ICW Integrated Cooperative Workspace

"Everywhere you look, the pace of activity is frantic . . . companies have pledged tens of billions of dollars toward highway construction.

Skeptics may disagree, but I believe that **the sheer impact of this revolution will rival that of the** electric light, the telephone, or **perhaps printing itself**".

Larry Ellison
CEO
Oracle Corporation

ICW Integrated Cooperative Workspace

WHO CARES?

- * Enterprise
- * Healthcare
- * Education
- * Financial Services
- * Information Agents

ICW Integrated Cooperative Workspace

THE MASSIVELY DISTRIBUTED ENTERPRISE

* Change
* Chaos
* Culture
* Control

ICW Integrated Cooperative Workspace

CSCW ARCHITECTURE

* The Need
* The Response

ICW Integrated Cooperative Workspace

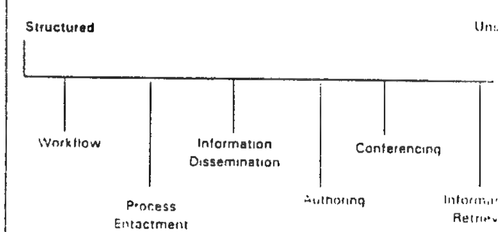
CSCW INITIATIVE CHOICES

BOOTSTRAP

BACK TO BASICS

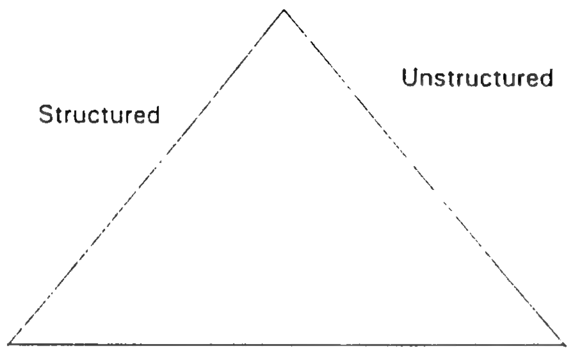
ICW Integrated Cooperative Workspace

CSCW SPECTRUM OF ACTIVITIE

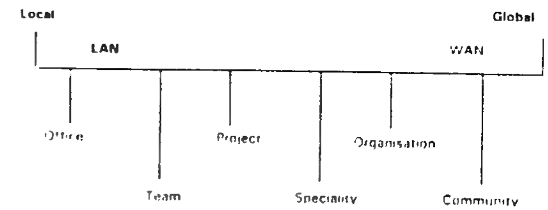


ICW Integrated Cooperative Workspace

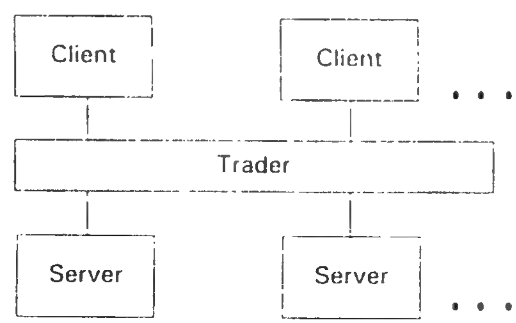
ACTIVITY MIX - Model



CSCW SPECTRUM OF ACTORS



THE ARENA
Open Distributed Processing



A virtual world requires an infrastructive; a substrate in whi the integrity of its behaviours ca be played out and extended with the context of individual needs . **The primary emphasis should be design a new collaborative mediu** rather than to describe interactio and interface technologies.

Carl Tollander
Cyberspace Project
Autodesk Inc

"There is a **general infrastructure requirement** for effective CSCW work: that is for **an open systems environment** in which material from different systems can be successfully exchanged without losing format or meaning in the process; and in which work can be **coordinated across and within different application programmes**".

P Wilson
"Computer Supported Cooperative Work"
Intellect, Oxford, 1991

ICW OBJECTIVES

* to understand and demonstrate how CSCW can be positioned within an enterprise IT framework.
* to CSCW-enable standards-based open computing technologies to which the partners are committed.

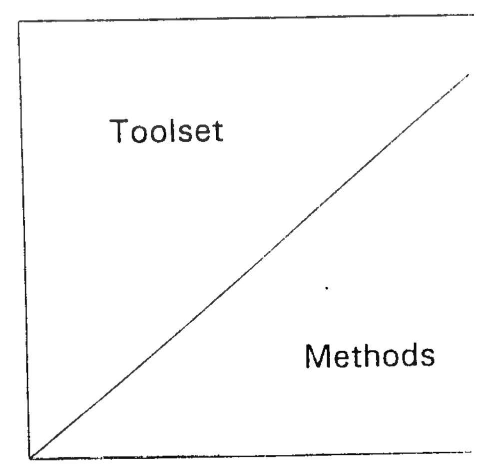
ICW Integrated Cooperative Workspace

ICW THEMES

* "Enterprise CSCW"
* Globalisation
* Virtualisation
* Standards
* Adaptability

ICW Integrated Cooperative Workspace

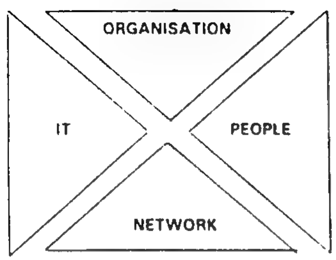
ICW DELIVERABLES



applied to demonstrators

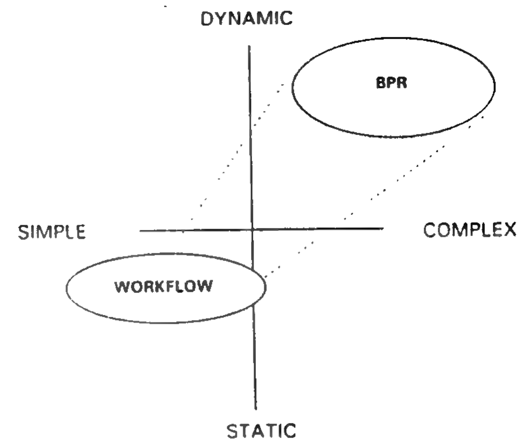
ICW Integrated Cooperative Workspace

CSCW & THE ENTERPRISE
ARCHITECTURE DEPENDENCIES

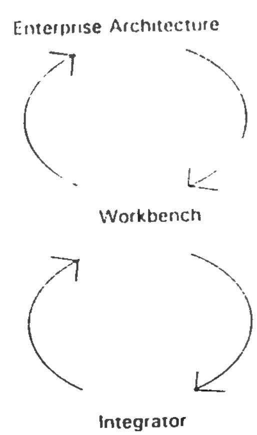


ICW Integrated Cooperative Workspace

CSCW & THE ENTERPRISE
Modelling & Enactment



ICW METHODS
ICL Processwise Portfolio



ICW METHODS
Concerns

* Holistic Architecture
* Value Added Representation
* Incremental Capacity
* Toolset Coupling
* Feedback Capture

ICW Integrated Cooperative Workspace

ICW COMPONENT LAYERING

USER LEVEL AGENT Persistent Workspace
CSCW CORE FUNCTIONALITY Trader Services
SERVICES Enterprise Browser
NETWORK INFRASTRUCTURE

ICW TOOLSET
Major Deliverables

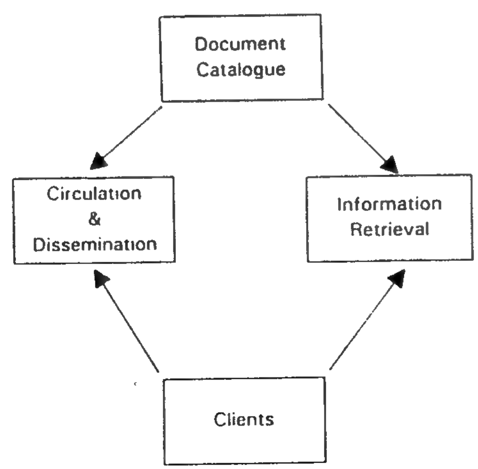
Persistent Workspace Manager
ICL

Enterprise Browser
Nexor

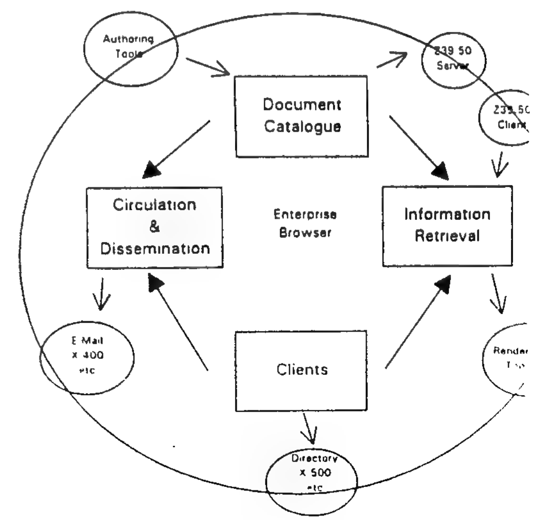
Distributed Information Access Kernel
Fretwell- Downing

Tool Wrapper Strategies
Consortium

ORACLE I-DOC
Pre - ICW



ORACLE I-DOC
CSCW - Enabled



Appendix H
STARTED - Strategies, Tools, and Resources for Team-based Early Design

TOMORROW'S ORGANISATION

8. TEAM-BASED EARLY DESIGN

THE STARTED CONSORTIUM

Roger Watson

CEGELEC Projects Ltd
Rover Technology
Bristol University
Ove Arup and Partners

The STARTED Project

Strategies, Tools And Resources for Team-based Early Design

Supported by the DTI and SERC
Project No 7000 of CSCW Programme

Computer Supported Co-operative Work

Roger Watson
Project Manager - STARTED

\slide\aware.1 Issue Date: 6/4/94

Objectives of STARTED

- Improve effectiveness of early design of large engineering projects
- Teams of users working together, and re-using work from others
- Reduce cost of up-front work
- Increase chance of project proceeding
- Reduce risk of project failing

This leads to

- Increased Business Profitability

Why a Collaboration?

- Tackling a difficult problem
- Solutions not obvious
- No one partner has all skills and knowledge to do it alone
- Complementary strengths create team more than sum of components
- Grant support helps companies tackle long term problems where solutions are uncertain and may not be usable for a long time

CEGELEC Projects Ltd
Rover Technology
Bristol University
Ove Arup and Partners

STARTED

Relationship to CSCW

- STARTED targeted at Co-operative Early Design Work
- Keen to use commercially available products where possible
- Partners are users of software products which support co-operative work
- Plan is for partners to use results to improve profitability of their established businesses
- Partners do not expect to become vendors of the tools developed

Concentrate: How to use

Tools: More Complex + "How to use"

"Engineered" →

"Stepping stone"

– Don't expect [illegible]

STARTED

Stages to Achieve Objectives

- Understand problem
- Propose a solution
- Specify tools to fulfil solution
- Design and Implement Tools
- Integrate Tools
- Evaluate by real users !!!

- Active interaction with real users at all stages !!!

Timetable

- Three year project 1994 to 1996

- Start Jan 94
- Prototype browser Sep 94
- Requirements specified Jan 95
- Basic toolset Mar 96
- Tools evaluated Dec 96

Description of Partners

STARTED Consortium consists of

- **Three Commercial Engineering Companies**
- **University**

REUSE

- **Engineering Companies have**

Different backgrounds
Common problems
A wish to share a common solution
Complementary strengths
All want to be users of project results

- **University has**

State-of-the-art knowledge
Research skills
Strengths in area of greatest uncertainty [Initial assessment

Universities give → expertise

Expert Specialization

Major Electrical Project Company

- **Business Interests relevant to STARTED**

  Produce tenders for complex systems
  Prepare outline design
  Prepare cost estimates

- **Interests in STARTED**

  Reduce cost of tendering
  Increase accuracy of cost estimates
  Increase re-use between projects
  Quantify risk in taking on Contract

- **Strengths brought to STARTED**

  System engineering and integration skills
  Information management skills

- **Contribution to STARTED**

  Project co-ordination
  Requirements for electrical project tendering
  Tool development
  Integration
  Tool evaluation

Major Automotive Manufacturer

- **Business Interests relevant to STARTED**

  Develop new vehicle models
  Estimate unit cost of new vehicle
  Estimate cost of manufacturing facilities

- **Interests in STARTED**

  Improve speed/accuracy of early design
  Increase chance of commercial success of new vehicles
  Earlier weed-out of less successful concepts

- **Strengths brought to STARTED**

  Skills in design of complex assemblies
  Skills in cost estimating and roll-up

- **Contribution to STARTED**

  Requirements for vehicle design
  Tool development
  Tool evaluation

Major Engineering Consultancy

- **Business Interests relevant to STARTED**

  Vehicle crash worthiness testing

- **Interests in STARTED**

  Increase information re-use
  Improve information accessibility

- **Strengths brought to STARTED**

  Consultancy and IT skills
  User of graphical and moving image information

- **Contribution to STARTED**

  Requirements for crash worthiness testing
  Independent evaluation of tools

Leading UK University

- **Interests in STARTED**

  Research into modelling of uncertainty
  Mathematics of estimation of effects of combining uncertainty

- **Strengths brought to STARTED**

  Research and IT skills
  Interests in cost risk assessment

- **Contribution to STARTED**

  Development of theory for cost/risk assessment
  Tool development

STARTED

Expected Results 1

- **Information Management System**

  Data base of mixed information
  Capture data itself and its relationships
  e.g. set of information describing a product
  sets of information for versions, variants or derivatives of a product
  traceability history

- **Hypertext Browser Tool**

  Browser allows user to search through large quantities of data
  Hypertext allows user to "click" on a subject of interest, and focus in on that area
  Visual/graphical approach is attractive and easy to use

- **Information Viewer Tool**

  Information in variety of formats, e.g. word processors, drawing packages, 3-D modelling, photographs, film
  When information found, need to use commercially available software for viewing

STARTED

Expected Results 2

- **Cost Roll-up Tool**

  Calculate total costs from elementary costs, taking account of integration.

- **Risk Estimation Tool**

  Quantify project uncertainty and risk from a mathematical combination of individual element uncertainty and risk

STARTED

Work Plan Stages

1. Study Business Processes
2. Produce Information Model
3. Identify Generic Information Model
4. Specify Tools
5. Implement Tools
6. Integrate Tools and Information System
7. Evaluate System

User Interaction

Strong interaction between users and developers

Users actively involved in defining problem (requirements definition) and in assessing usability of results (tool evaluation).

Iterative cycle
- Learn by experience
- Try ideas before committing

Engineering tools are intensive in use of Man-Machine Interfaces
- Ergonomics important
- Prototypes valuable for trying ideas

CONCLUSIONS

STARTED is targeted at

- Early design of complex systems

STARTED will provide

- Disciplined storage of large quantities of mixed data
- Browsing mechanisms to search the stored data to find re-usable information
- Retrieval mechanisms to support re-use
- Tools for cost and risk estimation

The goal is

- Increased business profitability

Appendix I
AAAI-94 Workshop on Models of Conflict Management in Cooperative Problem Solving

This workshop was the second major effort in conjunction with the major international conference in AI to explore a multi-disciplinary approach to conflict management. A number of well known researchers in this field contributed to this workshop. In AI, there is generally still a more narrow view of this problem, in that, this continues to be viewed as efforts in managing conflict of distributed artificial intelligent agents. However, there were several challenging presentations which brought out multiple perspectives to the problem.

Some of the more challenging perspectives, especially relevant to C3I included:

- *Knowledge Support Systems for Constructively Channeling Conflict in Group Dynamics*, by Mildred Shaw and Brian Gaines from the Knowledge Science Institute at the University of Calgary. They presented the theoretical foundations for individual and collective dynamics in terms of relations between knowledge structures. They argue that neither individuals nor collectives need to be consistent in their knowledge structures to achieve effective performance, and the notion of conflict arises in modeling failures in coordination attributed to such inconsistency. They presented methodologies for eliciting and modeling knowledge structures from individuals and groups to make overt the nature and sources of conflict.

- *The Model Class Discovery Dilemma in Computer-Supported Work Environments - From Critical Incidents to Metrics of Coordination*, by Rodney Fuller from Claremont Graduate School. He argued that due to limited resources, the main problem in designing tools for computer-supported work environments is to quickly find both a level of representation and a level of analysis that effectively explains the uncertainty that exists between design and environmental variability: "the model class discovery dilemma." Historically, CSCW designers have used critical incidents or design rationales. Fuller proposes designing on more fundamental "metrics of coordination."

Appendix J
CSCW94 Workshop and Conference

The Workshop, "Where the Rubber Meets the Road" was concerned with what human factors hinder the effective use of group support technology, and there were a number of people from government, academia, and industry who participated. While there was much in the Conference and Workshop that applies to supporting C3I with collaborative technology, the following impressed me as especially relevant:

- Cognitive mapping tools provide a means to organize group memory, however, the process of capturing the thoughts of those participating in group decision sessions is extremely difficult. Even with multiple, trained recorders, one third of the comments can be missed during these session. People who continue to use CM1, the cognitive mapping tool based on Group Issue-Based Information Systems, begin to use meta statements to clue the recording of one's statements. In fact, one of the more valuable contribution of CM1, may be that people become more precise as to what is an issue, position, and an argument. In side conversations with an IBM researcher at the Conference, the thought of using current speech technology to better capture these comments is an intriguing possibility. While, it may be a while before we get perfect speech translation technology, imperfect speech technology may be especially useful in these group decision tasks where spelling is less relevant.

- Filtering is key in any sense making activity in C3I, the tremendous difficulty in categorization remains a critical problem which needs to be researched.

- One especially intriguing demonstration and presentation was offered by Okada et al, from Keio University in Japan: "Multiparty Videoconferencing at Virtual Social Distance: MAJIC Design.". They have been researching the concept of "virtual" social distance, and using available technology, they have created a semi-circular, full-sized screen which can be placed in front of a participant in video-conferencing. These screens provide full visual cues, such as head movement, and pointing, and make one feel that distant participants are located at the comfortable social distance of 4-6 feet. This approach seems to overcome some of the limitations of current video conferencing and provide excellent "social presence". I think this could have immediate benefit for decision makers at the highest level who need to develop a "gut feeling" of the situation by being able to "read" the other participants. This technique seems to provide the "virtual social presence" that would make video-conferencing an acceptable tool, in high risk, high uncertainty decision situations.

- In CSCW, the scientific study of the way people work together and the intended use of technology to support work must be co-equal goals which are co-equally funded.